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Research article

Housing market activity diffusion in England and Wales

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Abstract: This paper considers housing activity transmission across space using local indicators of spatial association. Activity does not diffuse like a ripple across England and Wales. Elevated activity appears to be associated with a south east-north west divide. The south east grows more quickly than the north west for a period of time, after which there is a switch in rank order. It is argued that changes in activity is associated with changing credit conditions to which the south east is more sensitive. Furthermore, it is proposed that activity features a type of participant induced on to the market by favourable price changes and credit conditions. It is argued that the reduced activity associated with 'missing mortgage movers' post-2007 reflects the lack of mortgage mover participation, which could have negative consequences for the macroeconomy.

Keywords: local authority district; ripple effect; local indicators of spatial association; housing market activity; missing movers

JEL Codes: R21, R31, G21

1. Introduction

Mian and Sufi (2018) argue that credit supply expansions lead to a boom-bust cycle in household debt and real economic activity. In other words, credit is an important driver of business cycles. The rise in house prices driven by credit supply expansion is of central importance for the aggregate

economy, as it boosts production, consumption and employment (Leamer, 2007), Making their impact is amplified. The feedback effects between the housing market and credit supply expansions entail lenders providing more credit as they expect house prices to rise further (Allen and Gale, 2000). In a broader context, this is combined with progressively lax lending criteria and more aggressive borrowing (Leamer, 2007; Mian and Sufi, 2018) boosting house prices further.

Mian and Sufi (2018) posit that the downturn of the credit cycle is initially driven by a decline in aggregate demand, which is further amplified by constraints on monetary policy, banking sector disruptions, and legacy distortions from the boom. A downswing of the credit cycle (bust) should feature a severe restriction in lending. The 2008 downturn affected the number of market transactions much more severely as compared with price. Hudson and Green (2017) identify that since 2008-9, there are 400,000 fewer housing transactions taking place each year compared with the period before the financial crisis, of which 80% could be attributed to a fall in home purchases funded by mortgages. Andrew and Meen (2008) made a similar point about missing transactions in the 1990s following the 1989 bubble bursting. The benchmark to assess who is missing was contested. Ortalo-Magné and Rady (2004) suggested that the 1980s were unusual because of credit liberalisation and the rising trend in owner-occupation.

Where this credit 'lands' during either credit supply expansions or contractions will be a function of lenders' risk perceptions. Among housing markets, it is not uncommon for one to act as price leader to others. In the British spatial context, the south east of England, either in total or in part, is identified as such a leader. The dispersal of the price rise from the leader is often referred to as the ripple effect, which is a well explored phenomenon. However, a ripple effect in housing activity is not, since a reported average or median price does not provide a full picture of activity. The price a vendor is likely to accept will be a function of their loss aversion (Genesove and Mayer, 2001). In a thin market, reported price averages would be based on a relatively small number of transactions. One would anticipate that the value of real estate activity would be adversely affected by a credit restriction when only the lowest risk transactions are supported by lenders. A feature of the 2008 bust in the United States (Gueye, 2021) was that the credit provision and price trended in opposite directions.

Tsai (2019) avers that positive ripple effects in price related to London can rapidly affect nearby regions, ascribing this to information diffusion. By contrast, negative effects, which are found to be associated with northern regions, are ascribed to risks. A gap in our knowledge is whether the diffusion of price is reflected in housing market activity. For example, instances where market conditions are not tight, the leadership in sales value may come from more transactions and stable prices, which might displace London as a leading market. A supplementary issue is whether there are structural differences in diffusion activity following the financial crisis of 2008 when credit conditions were tighter.

Using exploratory methods, this paper sets out to provide a picture of the diffusion of housing activity across local authority districts of England and Wales using sales value as the measurement, thereby providing a novel approach. This measure of either sales revenue or turnover could be viewed as a broader measure of housing market activity than price for assessing market spillovers, capturing the interaction of price and quantity in the exchange process. The emphasis on transactions entails revisiting of the standard diffusion mechanisms found in Meen (1999). Stein's (1995) work on housing bubbles and market participation is incorporated into the 4-factors outlined by Meen. The paper is structured as follows. First, there is a discussion of credit and cycles in economic activity house prices.

This is followed by a re-examination of the ripple effect and housing market participation. Indicators of credit conditions are outlined next. There is a discussion of various methods where spatial autocorrelation is reviewed, and the data considered. The emergent results and their analyses are presented as a series of maps, hotspots and coldspots as they pass over the England and Wales economic space, followed by the conclusions.

2. Price cycles and credit

The analysis of house price dynamics is complicated, with growth being strongly cyclical (Pyhrr et al. 1999) and subject to occasional bubbles. There is autocorrelation in housing prices, which can be explained by a drift from rational behaviour. DiPasquale and Wheaton (1996) imply that the use of information is quite limited, such that price forecasting is posited to be myopic. McClennan et al. (1998) argue that the history of house prices influences future prices. If consumers experience heavily autocorrelated house prices, they will build that into their expectations, tending to make history repeat itself. Tsai (2015) suggests that autocorrelation in housing prices implies that agents are continuously reflecting on information. Where price overspill is concerned, this is information from elsewhere (Tsai, 2019).

Duca et al. (2021) observe that housing models now depart from convention and assume non-rational expectations. They also assert that a striking aspect of recent research is a growing consensus that credit supply shifts are a principal driver of house prices, and that household balance sheets and their interaction with lending practices are central elements of the financial accelerator in housing (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Palley, 2004). A financial accelerator in housing, as described by Aoki et al. (2004), is a positive shock leading to a rise in housing demand. This boosts prices, increasing the collateral of existing owners, thereby reducing their credit constraints, which leads to a further rise in lending for housing. Mian and Sufi (2018) emphasise that a credit-driven household demand channel is distinct from traditional financial accelerator models primarily due to the centrality of households as opposed to firms. Drehmann et al. (2012) find that cycles of between 8 and 30 years are more important than those of shorter periodicities in credit, credit/GDP (Gross Domestic Product), house and equity prices, and GDP, across seven OECD (Organisation for Economic Co-operation and Development) countries, including the UK. The longer cycles in credit and prices are important for explaining bubbles. Aikman et al. (2015) found a 13-year periodicity in credit within a 130-year series of UK data: real loans and credit provision are pro-cyclical, with an amplitude twice that of the general business cycle, but a periodicity that is twice as long as the one for GDP.

The interaction between household balance sheets, risk, and housing market activity is explored in Stein (1995). They analyze the impact of rising prices on three house owner groups. The first group relates to those already wishing to buy when there is a price rise. An owner's balance sheet is enhanced by the rising price. Not only does this fortify their collateral but, as a lower risk, this would grant them greater access to credit, which leads to a further rise in demand for housing. The rise in equity affects the second group, who were not in the market. This group is induced onto the market by the prospect of taking advantage of their equity windfall. As they could now better fund a house purchase, they then switch to house searching. Stein asserts that this group is not a price accelerant, as it is adding to both

supply and demand to the market. As far as market activity is concerned, it increases the number of transactions and improves market liquidity.

Prospect theory points to loss aversion (Genesove and Mayer, 2001), where that owners are less willing to sell under loss conditions. This implies market participation and agreed price will be asymmetric compared with activity. Following a fall in price, dwellings will be withdrawn from the market, so that the average price, based on fewer trades, could underplay the extent of market contraction.

The third is the unconstrained mover group, where the price of housing is related to the proportion of income that the owner is prepared to apportion to housing consumption. These should decline to participate with price. An extension to Stein (1995) incorporating first time buyers is due to Wheaton and Lee (2009), who argue that higher prices lead more households to choose renting over owning. Unlike repeat buyers, higher prices adversely affect first time buyers' access to credit, therefore decreasing transactions as price rises.

The interaction with lending practices and credit cycles is discussed by Leamer (2007). An environment of rising prices not only relaxes credit constraints, but possibly through myopic forecasting, fosters unrealistically favourable expectations about the future. Taking a greater optimistic view about future prices by both the individuals and the lenders justifies a weightier debt burden that the borrower shoulders. Additionally, lenders push for a less regulated environment where normal credit checks are watered down. Lenders may still lend even when borrowers are not able to meet their capital repayments. When interest payment obligations cannot be met, the Minsky point forces mortgagers to sell the house; this is the turning point when the bubble bursts. In the cold light of day when government inquiries follow, there is a consensus that commonly involves stronger monitoring and further regulations to prevent the episode from reoccurring. Over time, these regulations are undermined by thwarting institutions, so that the high-risk lending does reoccur and what emerges fits a medium-term cycle perspective in credit.

3. Diffusion and the ripple effect reconsidered

Meen (1999) proffers four explanations at the regional level, that are well rehearsed elsewhere, which explain price diffusion through various channels, based on a shock to a market. If one were to accept that changes in credit supply, rather than either technology shocks or permanent income shocks, explain expansion and contraction in economic activity (Mian and Sufi, 2018), and that the focus of the paper is market activity rather than price changes, Meen's four explanations could be adapted. Envisage four housing market participant types. Type 1 is a buyer with no housing equity, who is possibly a renter looking to be a first-time owner. Type 2 is both a buyer and seller, currently participating in the market, wanting to move. Type 3 is a potential Type 2 seller who can be induced onto the market when their reservation price is passed. Unlike Type 2 they are a speculative mover and could enter and leave the market at little cost. The first three types are credit-constrained, and could benefit from a relaxation of lending criteria. Type 4 are non-credit constrained movers.

The first of Meen's four explanations does not involve space and is the most amenable to the adaptation above. He posits that regional regressors follow a similar configuration. In other words, if the determinants of local house prices are the same across space, such as national macroeconomic forces, regional prices will rise in accord. If credit conditions are relaxed, Type 1 and 2 buyers should

benefit from the capacity to borrow more. Initially, this will reduce the credit constraint, thus facilitating a better match between the buyer and their preferred purchase. Transactions should therefore increase (Berkovec and Goodman, 1996). However, the greater competition for dwellings could push up prices, adversely affecting affordability for the next wave of Type 1 participants. The relaxation of credit should have a greater effect on higher priced markets, where constraints bind the tightest or in those markets seen as the lowest risk. Type 3 participants will be induced on the market following the rise in prices and the greater availability of credit. This increases transactions and the value of sales.

The second of Meen's four explanations entails the regional price moving out of line with established norms. In the context of relaxed credit constraints, rather than discussing a price shock *per se*, the local market price could accelerate more quickly that credit conditions are relaxed forcing some market participants, most acutely for Type 1, to extend their search into a belt of neighbouring, substitute areas. The rise in price would displace transactions from local to these substitute areas, boosting activity and forcing up prices there.

The third explanation entails owners migrating to take advantage of price differentials. This arbitrage should pass price increases on to other areas. In this scenario, Type 2 participants add properties-to-sell in the donor area's market and boosts demand in the target market. Unlike the second explanation, the third is not clear regarding the proximity of the recipient with the donor market. This explanation is more about price leadership than a ripple effect.

The last explanation entails expectations and spatial arbitrage, rather than physical flows, in mediating prices. If two market areas are believed to be linked in some leader-follower arrangement, the rise in property prices in the leader market would, following expectations theory, lead to Type 2 participants in the follower market to revise their asking (expected) price upwards; however, this does not affect the number of transactions.

A key difference when considering housing activity rather than price alone is the impact of Type 3 participants, who add liquidity in both buyer and seller markets. Where their dwelling is situated, the decision to sell adds to the number properties on the market, deflating price and boosting sales turnover. In their target market, they increase the likelihood of a seller finding a buyer. If price rises there, as Meen projects, local Type 3 sellers should be induced on to the market. Hudson & Green (2017) note that only 10% of house moves are job related, implying Type 3 participant can be seen as a major actor in the credit accelerator. The total credit provision would reflect their participation.

Additionally, the entry of a Type 1 buyer can facilitate more than just one transaction, but a series involving Type 2 participants that are mutually dependent, in a so-called property chain. This may not affect price but could be significant for transactions. This may be more of an issue where there is a market glut, and dwellings are being sold at a much-slower rate. Here, activity could increase without the price rising, leading to increased mortgage advances from more transactions and stable prices.

A supplementary issue is whether there are differences in activity-diffusion following the financial crisis of 2008, when credit conditions are tighter. Allen and Gale (2000) argue that higher price levels are supported by the anticipation of further increases in credit and house prices in general. Following Leamer, a downswing of the credit cycle (bust) features a severe restriction of lending, which would affect Type 2 and, with a fall in price, a Type 3 participant. Additionally, equity would be reduced. The Type 1 buyer should benefit from a fall in price. However, in a more risk averse

environment, as they are more reliant on mortgage funding, they would face finding much larger deposits as lenders filter out the higher risk borrowers.

4. Relevant literature on the ripple effect

Much of the empirical literature on housing markets has tried to answer questions, such as "Is there a stable long run equilibrium between regional house prices?" There are numerous examples across a variety of countries that are cited where cointegrated regional house prices have been revealed (*inter alia* Alexander and Barrow, 1994 (UK); Stevenson, 2004 (Eire); Shi et al., 2009, (New Zealand)). However, the error correction approach to revealing a ripple may not capture the complexities of the dispersion of market activity. As cointegration implies common [price] trends, dissimilar growth is not posited in the long run. Indeed, the ripple effect would fall within this analysis (Alexander and Barrow, 1994).

As analytical techniques develop, price diffusion is re-examined, though this can prove problematic. Gueye (2021) examines the importance of cross-section dependence in the analysis of housing prices panels using 20 national data sets from 1997–2020. Cross-section dependence refers to serially correlated errors between the cross-section units of a panel. This could emerge from proximity, interest rate shocks, or being affected by similar banking policies. First-generation tests (tests which assume cross-section independence) finds no evidence for either stationarity or cointegration whereas second-generation tests (tests which assume cross-section dependence) reveals strong evidence for both stationarity and cointegration. With a second-generation approach, Gueye (2021) finds housing prices have a positive long-run relationship with real GDP and construction costs, and a negative cointegrating relationship with the real interest rate. That said, real housing prices were not consistently following these relationships, with prices falling with trend real interest rate, whilst the real GDP rose during the early phase of the Great Recession post-2008.

Using data from January 1995 to July 2017 in nine regions in England and a combination of MGARCH and VECM models, Tsai (2019) examined the diffusion of price (return) and volatility (risk). They claimed that empirical models of past studies are inferior, as they only discuss either market integration or risk estimation separately; consequently, they cannot be used to identify whether correlations between markets are attributable to return or risk diffusion. Volatility in housing markets in the southern regions is found, except for times when financial crises occurred. Housing market risks are lower there than in other regions. They are affected by changes in the interest rate. London's housing market exhibits low risk and high return and price diffusion to other markets is high. By contrast, ripple effects attributed to volatility are more often found in the northern regions during the down phases in a business cycle.

Rather than searching for cointegrated prices some authors seek to show the ratio of regional to national house prices is stationary. Again, at the UK regional level, Tsai (2015) finds a segmentation in housing markets between the northern and southern regions. Housing prices in the northern region decline more easily than they rebound. For a narrow window around the time of the financial crisis there is overspill among northern regions. The declining spillover indices after 2009 suggests a lack of recovery, leading to a gap between prices in the northern regions and other regions after the financial crisis. The London housing market is segmented from the overall UK housing market. Additionally, the south east region leads others by one month.

Applying a conventional parametric unit root approach and two alternatives that allow for threshold effects and structural breaks, Balcilar et al. (2012) confirms a ripple effect in house prices across five metropolitan areas in South Africa. Factor analysis reveals Cape Town and Durban to be the cities that tend to drive the housing markets elsewhere. They conclude that less sophisticated approaches still produce solid results.

Diffusion within an urban area has been explored by Blake & Gharleghi (2018). Using pairwise co-integration multivariate co-integration they find that suburban districts of Sydney did not have common trends; however, using strings of districts and multivariate cointegration among the suburb strings, that were geographically further from the central business district and that were lower priced. Granger causality results suggest that there are price spillovers from surrounding suburbs without price leadership.

Holmes and Otero (2022) generate a large-scale error correction model of London borough house price growth. Borough house price inflation responds to decreasing dwelling affordability. Moreover, if housing price levels increase faster than income levels so that borough affordability decreased, borough house price inflation will fall in response with a half-life range of 1 to 2.5 years in terms of borough house price inflation responding to a shock in borough affordability. Spillover is found between neighbouring boroughs, rather than nearby spaces, challenging the use of a weights by distance matrix in spatial autocorrelation work. Evidence for a ripple effect is not strong, and if found house price shocks ripple outwards from London to the rest of the United Kingdom, rather than vice-versa.

Additionally, articles featuring the ripple and transactions are less common. Tsai (2014) uses a ratio approach to the ripple analysis in both price and transactions. The ratio approach, benchmarked against the UK, is a means of assessing convergence. The timing and the size of the deviation from the long run ratio in price is compared with that of transactions. On an individual regional basis convergence is rarely found. However, by using panel unit root tests, they found that UK house transaction volumes were in disequilibrium across 2000, 2001, 2008, and 2009, but convergent in other years. House price and volume during 1995, 2010, and 2011 both converge to an equilibrium. Tsai (2018) found the ripple effect in transactions of four regional housing markets in the US were far more evident than that in housing prices, and that the two types of ripple effects are negatively correlated so that information between regional housing markets is either transferred through price or volume.

Non cointegration/stationarity work are less common. One such relevant example entails analysing the ripple effect at differing cycle periodicities. Lo Cascio (2021) finds regional housing returns shocks diffuse outwards form London with declining strength, proportional to the distance. In the long run, London is leading everywhere. The highest coherence is found with its Outer Metropolitan and Outer south east, with which share common cycles, and the 3–16 years bands when there is almost synchronicity for the entire sample period except for the crisis. Corresponding well with Drehmann et al. (2012) and Aikman et al. (2015), she finds a 15-year cycle for most of the regions, driven by finance, which integrates the regional housing markets. The north west leads London at the 1–3 years cycle in 1999 and 2003 and after 2011. West Midlands leads London from 2008 to 2014 in the business cycle range of 6–8 years.

5. UK credit indicators

Figure 1 displays indicators of activity and credit conditions for England and Wales (E&W) for the study period. Hudson and Green's (2017) missing movers are evident in the significant drop in transactions in 2008. Additionally, three Bank of England[1] credit series are displayed. One reveals credit conditions for individuals and the other the provision of credit mortgage and credit card providers. The last of the four series is of the Bank of England base rate. Credit growth was declining from 2004 for individuals, only growing from 2009. Although less abrupt, the Z shape reflects that seen in transactions. Outstanding loans to corporates peaked in 2008, but dramatically fell the following year and stayed low. This would capture perhaps the less risk-averse lending expected at the end of a credit boom, as projected by Leamer. Miles and Monro (2019) estimate that the sustained decline in real interest rates between 1985 and 2018 can account for all of the doubling of house prices relative to incomes over that period. Driving base rate to be around zero did not offset the fall in the credit provision in the post-2007 period.

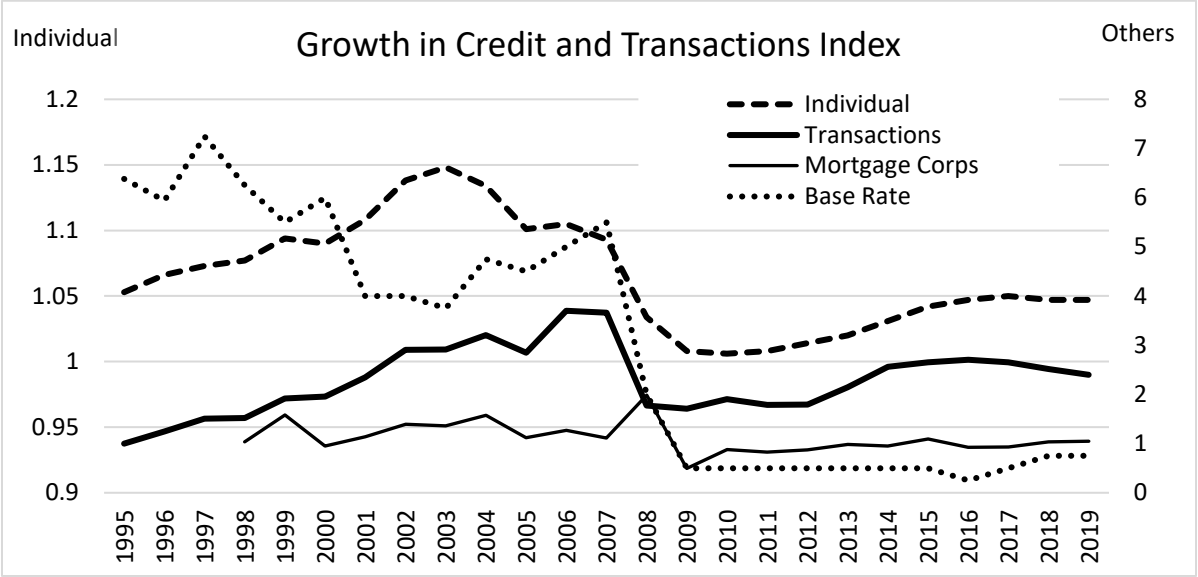


Figure 1. Credit conditions and transactions.

Figure 2 displays two standard lending metrics used to assess affordability of home purchase. Loan to Income (LTI) and Loan to Value (LTV) metrics[2] for repeat (Type 2, or 3) buyers (RB) and first-time buyers (FTB or Type 1) for England. Initially, LTI are at 3.14 and 2.46. There is a spike in

[1] Annual amounts outstanding of UK resident monetary financial institutions' sterling net lending to mortgage and housing credit corporations (in sterling millions) not seasonally adjusted RPATBVN Monthly 12 months growth rate of total sterling net lending to individuals (in sterling millions) not seasonally adjusted LPMVTXY.

[2] Table 15 Housing market: simple average house prices, mortgage advances and incomes of borrowers, by new/other dwellings, type of buyer and region, United Kingdom, from 1992 (quarterly) 1,2 (previously DCLG table 514) https://www.gov.uk/government/collections/uk-house-price-index-reports.

2002 within the LTI patterns but otherwise, housing becomes unaffordable, progressively. Perhaps a better measure of lender-risk appetite is the LTV of the FTB. This declined from a high of 0.9 in 1995 to a low of 0.68. However, there is a dramatic drop from 0.82 to 0.68 in the three years to 2009, aligning with the decline in overall credit seen in Figure 1. The pattern of sales value, which closely resembles transactions, highlights a notable different in growth pre and post 2007. After 2007, there is no return to earlier growth patterns, yet the LTI pattern seems infrangible, suggesting a thinner market going forward. Moreover, prices are rising, which should encourage greater participation. The constraint on participation could be revealed by the LTV. Price is rising whilst the LTV falls. In real terms based on 1995 retail prices, the average deposit rose from £5,000 to £30,000, or a quarter of the 'average income notified to lenders,' (or income) to over 100%. The rise in deposit size occurred pre-crisis, around 2003, rather than post 2008. Indeed, affordability metrics show a decline rather that a structural change associated with the collapse in transactions. The same issue affects RB. The differential between the average advance and the average price sold jumped from £33,000 to £71,000. Building up such reserves will take time, extending the interval between house moves.

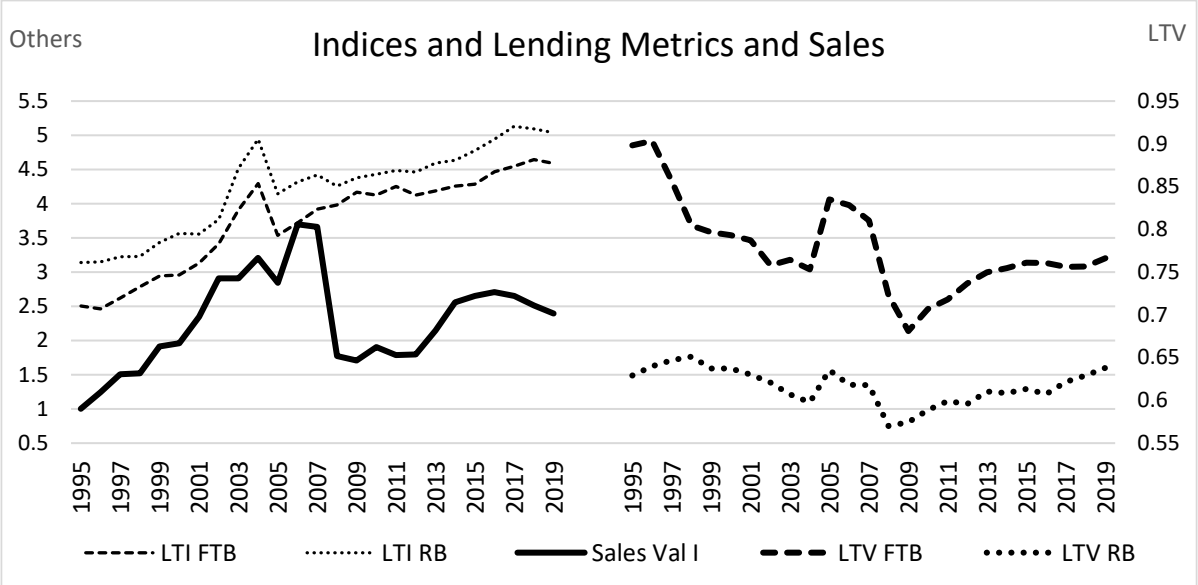


Figure 2. Mortgage lending metrics.

6. Method

Cointegration implies common (growth) trends but needs a sizeable number of data point to estimate parameters, where there are limited number of point non-parametric tests can prove useful, without much loss of power. A Friedman test of ranks is applied to test growth rates across the *k* regions at each time *t*. The null of common medians is not rejected if, repeat *T* times and calculating the average rank score for each region, there is no difference in the mean-ranks. The Friedman statistic is defined as $F_r = \frac{12\sum_{j=1}^{k} R_j^2}{\Lambda} - \frac{3\Lambda}{k} \sim \chi^2_{k-1}$ where $\Lambda = Tk(k+1)$, T = number of time periods, k = number of variables (Regions) and R_j = sum of ranks in the *j*th column. For there to be common trends, there should be no difference in regional growth rates. Page presents a test with the same null but for an

ordered alternative hypothesis. The statistic $L = \sum_{j=1}^{k} jR_j = R_1 + 2R_2 + \cdots + kR_k$ is put against critical values for small samples reported in Siegel and Castellan (1988: Table N). If the null is rejected it is inferred that the growth rates are of increasing size given by the *a priori* order.

Exploratory spatial data analysis is a term that covers a variety of techniques that reveal, visually or numerically, clusters of some activity. Local indicators of spatial association (LISA) identify cases in which the comparison between the value of an observation and the average of its neighbours is either more similar (high–high (HH) or hot spots, low–low (LL) or cold spots) or dissimilar (low–high (LH), high–low (HL) than one would expect from pure chance. They are useful tools that can expose areas in which values are concentrated and provide suggestive evidence about the processes that might be at work. A key use is to visually highlight spatial boundaries. For example, Guillain et al. (2006) ascribe employment centres and isolated poles to HH and HL combinations in a core-periphery analysis of the Ile-de-France area. Le Gallo and Ertur (2003) reveals that spatial clusters of high and low per capita GDP throughout the period are an indication of the persistence of spatial disparities among European regions. Gray (2023) highlights the similar boundaries of clusters of migrants of family-starting age and districts with distinctive house price-earnings ratios.

As most of the work in the ripple effect at the national level is undertaken with regional data, it is not clear how price diffusion passes through these large spatial units. One possibility is that diffusion is passed down through nodes to their hinterlands (Oikarinen, 2006). Alternately, activity could pass from one neighbouring tract to another as the ripple effect is posited to be at the regional level. Maps of either hot or cold spots should be able to reveal differential growth rates consistent with both scenarios. The former could emerge as multiple clusters centred on primary urban areas. For example, these could be closely interlocked with London by rail links, allowing proximity to London to emerge as a factor.

Gray (2012) highlights clusters of tracts where house price growth is relatively intense (hot spot) or sluggish (cold spot). Using a series of LISA maps, he tracks the movement of clusters across English and Welsh districts. He reports that there is a large spot around London and another in the north west of England that switch roles. In 1998, the high growth cluster was centred on the former. By 2004, this had switched to the latter. Both hot and cold spots emerge and pass over the east and southwest of Britain. However, he suggests that diffusion is not found beyond the East Midlands. Subsequently, there are jumps in regimes where much of the north of England switch from cold to hot as one. Diffusion from centre to periphery was not evident.

A local indicator of spatial association is defined as $\frac{\sum_j w_{ij} z_i z_j}{\sum_i z_i^2}$ (Anselin, 1995). Each is a component of Moran's *I* the corresponding global measure of spatial association *I* which is defined as $\frac{\sum_i \sum_j w_{ij} z_i z_j}{\sum_i z_i^2}$ (Anselin, 1995) where $z_i = x_i - \bar{x}$ and *x* is the growth rate. The extent of a revealed cluster depends on type of weights matrix and the limits associated with it. An inverse distance matrix is selected as it can capture association between non-contiguous spaces with declining influence with distance. The inverse distance weights matrix is defined as $w_{ij} = \frac{1/d_{ij}}{\sum_j 1/d_{ij}}$ and $w_{ii} = 0$. A distance limit of 80 km or 50 miles reflects a one-hour journey to London on the fastest trains. To cater for multiple statistical comparisons, the level of significance is adjusted. Anselin (1995) argues a Bonferroni adjustment is too conservative. Le Gallo and Ertur (2003) recommend the adjustment

be based on the number of near neighbours. All bar five districts have 10 or fewer neighbours, so the adjustment entails using 0.5% pseudo-level of significance, which corresponds with a false discovery rate of around 0.25%.

7. Datas

Excluding the Isles of Scilly and City of London, which have intermittent data, there are values for 329 English and Welsh Local Authority Districts on house price and sales, supplied by the ONS (ONS 2020)[3]. The growth rates expressed as the ratios of one year's value divided by the previous year's and are displayed in Table 1. The England and Wales (E&W) average price rose by a factor of 2.29 which is a product of 2.33 over the first half and 0.98 in the second half of the period. In other words, price in 2019 was below that in 2008 in real terms. Sales volume was essentially flat [1.05] but as with price, the first half growth [1.60] off-sets the second half decline [0.66]. The product, sales value [2.4], has elements of both. In Figure 3, all three growth series show sawtooth change, in which rapid growth in one year is followed by sluggish growth in the second year. Annual price growth was negative in 2008, 2011, 2012, 2017, 2018, and 2019, whereas sales value growth was also negative in 2005, 2007, 2009, and 2011, but not in 2012. Annual transactions growth was negative in 13 of the 24 years and seven of the last 12. It is clear that price variations are much smaller than the other two. This is reflected in having to use the right-hand scale to show variations. Volatility in activity is associated with volume rather than price.

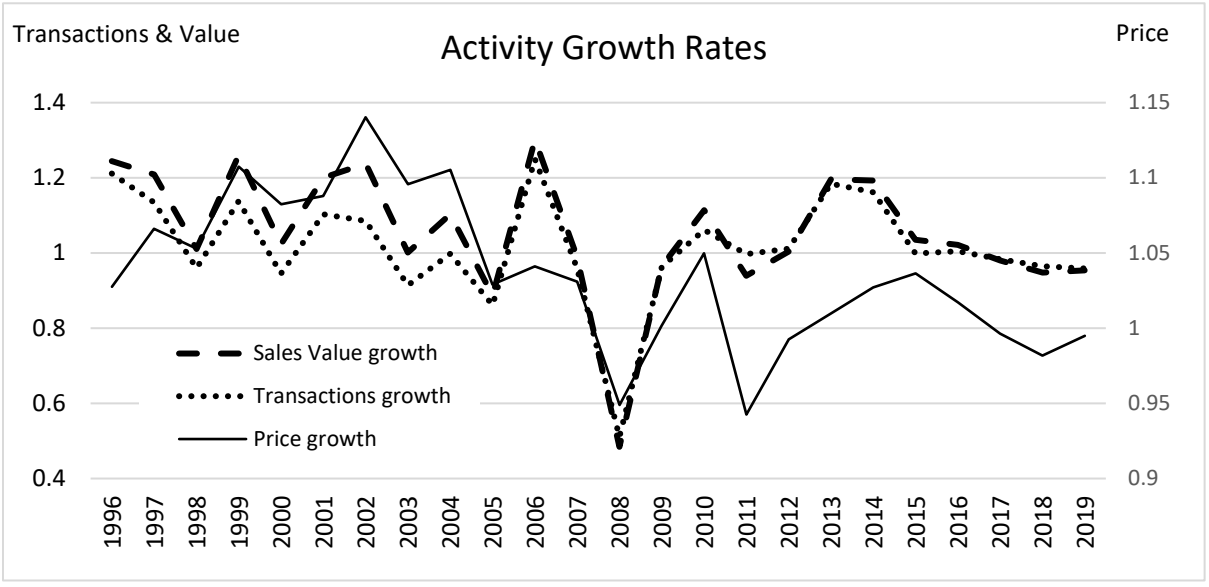


Figure 3. Growth rates.

[3] https://www.ons.gov.uk/peoplepopulationandcommunity/housing/datasets/numberofresidentialpropertysalesfornationalandsubnationalgeographiesquarterlyrollingyearhpssadataset06.

At the regional level, the fastest growth rate in transactions volume is found in Wales' figures, whilst it is associated with one of the slowest price growth rates; alternatively, London has the opposite characteristic. Indeed, both regions are quite consistent in their leadership of these measures. The northern regions of the north east, north west, and Yorkshire-Humberside exhibit sluggish growth in both periods; however, similar to Wales, these regions have better transaction growth values. Despite a fall in the number of transactions, the value of transactions in London increased by 3.9% annually, slightly more than the national rate, but below Wales'.

Table 1. Tests of common activity growth rates.

	Price					Transactions					Sales Value				
	Growth Rate		Friedman			Growth Rate		Friedman			Growth Rate		Friedman		
	Ist	2nd	Ist	2nd	All	Ist	2nd	Ist	2nd	All	Ist	2nd	Ist	2nd	All
NE	2.10	0.84	0.82	0.79	0.81	1.87	0.61	1.05	0.99	1.01	3.88	0.52	1.14	0.82	0.98
NW	2.19	0.90	1.02	0.88	0.91	1.70	0.68	0.94	1.24	1.09	3.67	0.62	0.94	1.09	1.01
YH	2.17	0.89	0.79	0.82	0.80	1.68	0.68	0.97	1.17	1.07	3.58	0.61	0.96	0.97	0.96
EM	2.24	0.95	1.00	1.11	1.06	1.61	0.72	0.97	1.09	1.03	3.54	0.69	0.88	1.20	1.04
WM	2.14	0.94	0.92	1.00	0.97	1.54	0.73	0.86	1.26	1.06	3.23	0.70	0.82	1.23	1.02
EE	2.37	1.06	1.08	1.26	1.17	1.54	0.66	1.11	0.85	0.98	3.58	0.70	0.99	1.05	1.01
LON	2.61	1.28	1.23	1.40	1.31	1.54	0.50	1.06	0.62	0.84	3.94	0.63	1.18	0.86	1.02
SE	2.35	1.03	1.09	1.21	1.16	1.51	0.64	0.96	0.74	0.85	3.49	0.66	1.02	0.86	0.94
SW	2.50	0.92	1.12	0.91	1.02	1.57	0.72	1.09	0.76	0.92	3.86	0.67	1.11	0.86	0.99
WA	2.32	0.84	0.94	0.64	0.79	1.72	0.78	1.00	1.29	1.14	3.92	0.66	0.99	1.06	1.02
E&W	2.33	0.98				1.60	0.66				3.66	0.65			
χ^2			6.66	20.24	22.38			2.04	21.22	7.36			4.64	7.69	0.74
p-value			0.67	0.02	0.01			0.99	0.01	0.60			0.87	0.57	1.00

Note: Ist period 1995-2007; 2nd period 2008–2019; Southern: EE=East of England, Lon= London, SE= South East, SW=South West; Midlands: EM=East Midlands, WM=West Midlands, WA=Wales. North NE=North East, NW=North West, YH=Yorkshire/Humberside E&W = England and Wales.

As an initial exercise, a Friedman test of a common long run growth rates is outlined in Table 1. The mean ranks are divided by 5.5 so that if the annual growth rates for a particular region over the 24 years has a value of greater than one, the regional growth rate is above the median rate. The null of common price growth over the 24 years is rejected (χ^2 = 22.38 [0.01]), but this is not the case for transactions (7.36 [0.60]) and sales value (0.74 [1.00]). The values seen in Table 1 are consistent with Tsai (2015) who finds London's housing market is segmented from the overall UK housing market. She was using price as the indicator of activity. This division is not evident in transactions or value. The period is bifurcated to reflect the schism caused by the financial crisis, and the tests are run again. For the 12 years from 1995, there is no difference in price growth rates across the regions (6.66 [0.67], but there is in the second 12 years (20.24 [0.02]). Analysing the period from 1995 to 2012 Tsai (2014) finds that the transaction variables in the 10 regional housing markets in UK have significant joint volatility relationships with those of the entire nation, suggesting that transactions are more likely to be a function of a common relationship, most likely credit.

Interestingly, a schism is found in transactions in the second period. With this, London seemingly swaps roles with Wales, Where London has the lowest transactions growth rate. The Friedman test statistics implies that there is differential growth in prices but not in sales value, indicating an inverse relationship between transactions and price growth, at odds with Berkovec and Goodman (1996). Despite the reciprocal appearance, a Page test, using the regional rank order of transactions values as the *a priori* order for price growth, does not support the notion statistically ($L = 3610.2 < 3788$).

8. Spatial analysis results

Moran' *I* correlates the growth rates of a representative district with its neighbours. In only nine years, is there a value of *I* over 0.1. Indeed, in 1998, 2005, and 2015, there is not a significant spatial autocorrelation at the global level. Serial correlation concerns the relation between the growth rate of the representative district in the current year with the rate the year before. In the main, the spatial correlation values are lower than the serial correlations (not reported). Peak *I* in 2003 is associated with a serial correlation coefficient of 0.22. The switch from hot to cold spot over 1999–2000 is associated with a peak serial correlation coefficient of −0.42. The spatial correlations regarding transactions values are very much smaller than Gray's (2012) for the same years, but in price. Again in 2000, regarding price inflation, Gray (2012) reports Moran's *I* is over 0.6. The corresponding value for sales is 0.12. From this, it is concluded that housing activity is more serially correlated, whereas price growth is more spatially correlated.

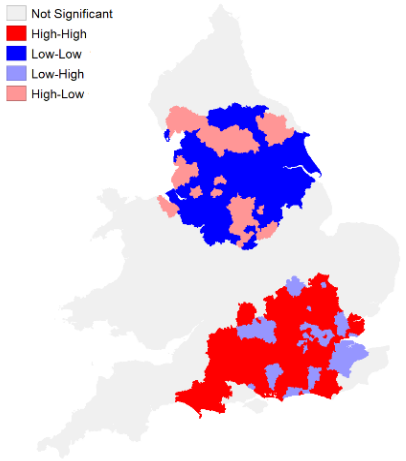
Following the analysis of Table 1, leadership would imply a regular change in which is the fastest growing region, reflecting spatial diffusion of growth. Over the 24 years, London is either at the top or the bottom of the league table of growth rates for ⅔ of the period. These were generally consecutive years, such as during 1996–1999, when it had leading growth rates but were at the bottom over 2014–2018. Looking at groups rather than individual regions, London, East England, and south east occupied three of the four top spots in 1996–1999, 2009, 2010, and 3 of the 4 bottom places in 2002, 2003, 2017, and 2018. The north east, north west, and Yorkshire-Humberside occupy three of the four top spots in 2000, 2003, 2004, 2017, 2019, and three of the 4 bottom places in 1996, 1997, 1999, 2001, and 2009. Rather than a progressive change from leader to follower there are swings centring on a north west-south east axis, a pattern not consistent with a rippling of activity across space.

Figure 4 features 24 LISA maps of growth rates of housing trading revenues across England and Wales, of which the first half are directly comparable with Gray's (2012) work. Using LISA maps, Gray (2012) finds there is evidence of price diffusion across the south of England and midlands but beyond this there are either jumps or switches in regimes. As hot spots do not move across the map in a manner seen in Gray (2012), the notion of a ripple cannot be applied to activity. In the run up to the financial crisis, the maps of 1996, 1997, and 1999 highlight a cold spot in the north west area and hot in the south east. In 2002 and 2003, these are reversed. Particularly over the south east area, the cloud remains for possibly 3 years in a row, which aligns with the high coherence among Outer Metropolitan, Outer south east, and London (Lo Cascio, 2021; Tsai 2019). Consistent with the regional rankings there are swings centring on a north west-south east axis.

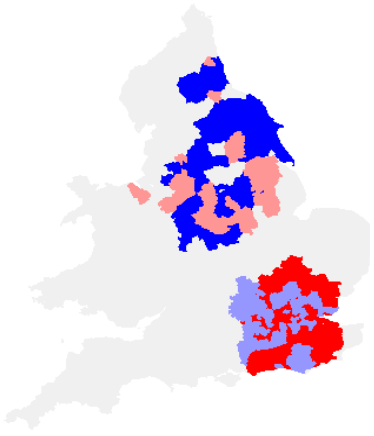
In the low activity period, post 2007, anomalies are found in 2010, 2012 and 2016–2018 when the northern and southern regional groups are not in the top and bottom four regional spots. Yet the

south east area has a cold spot hovering over it from 2016, with hot spots in 2010, 2012, and 2013. The north west is covered by a cold spot in 2009 and 2010, and hot in 2015, 2016, and 2019.

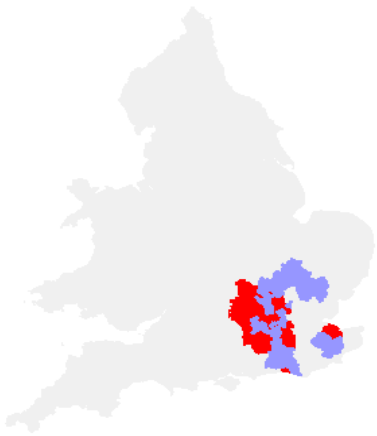
1996 I = 0.205 [0.000]



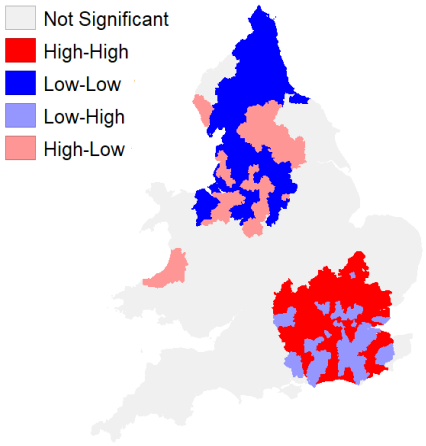
1997 I = 0.136 [0.000]



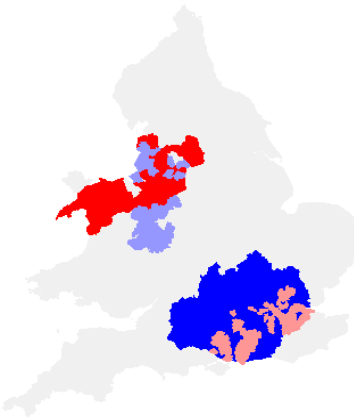
1998 I = 0.017 [0.060]



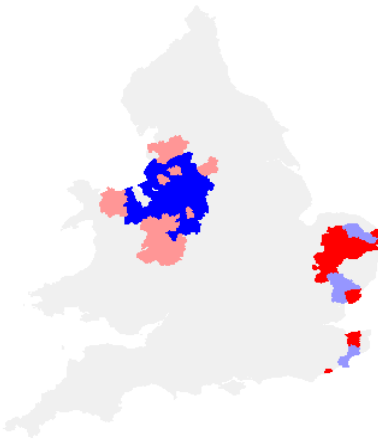
1999 I = 0.191 [0.000]



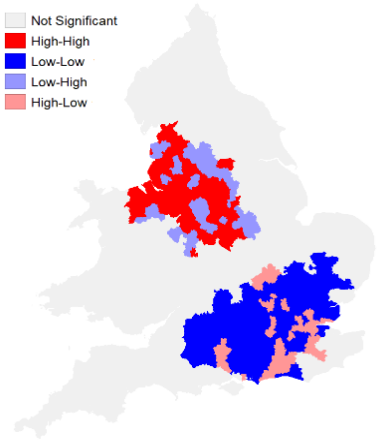
2000 I = 0.12 [0.000]



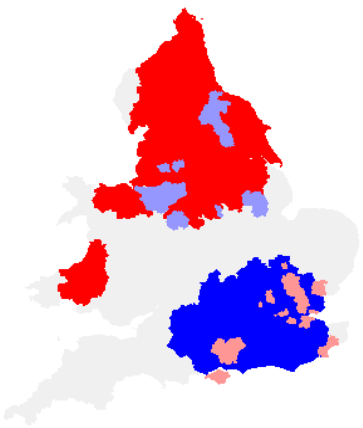
2001 I = 0.051 [0.001]



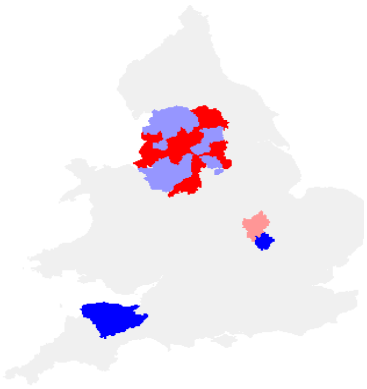
2002 I = 0.159 [0.000]



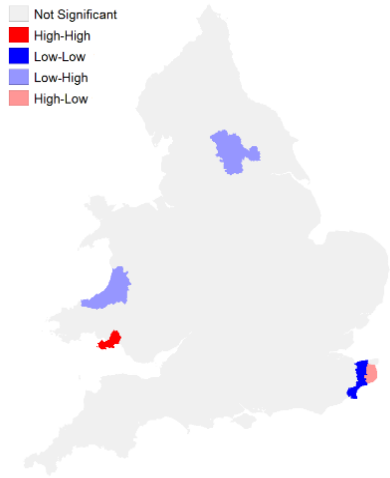
2003 I = 0.477 [0.000]



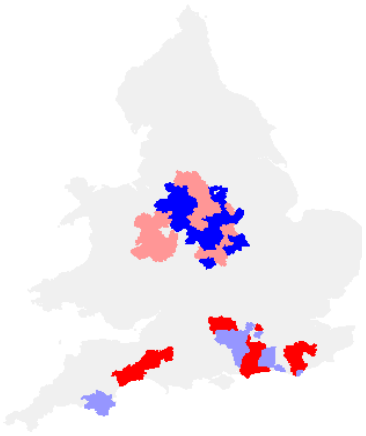
2004 I = 0.049 [0.004]



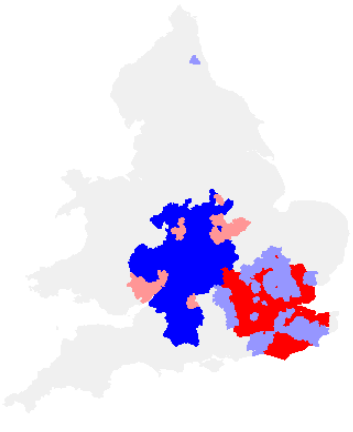
2005 I = 0.013 [0.100]



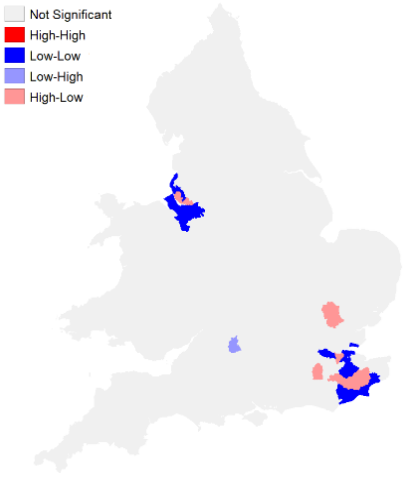
2006 I = 0.058 [0.002]



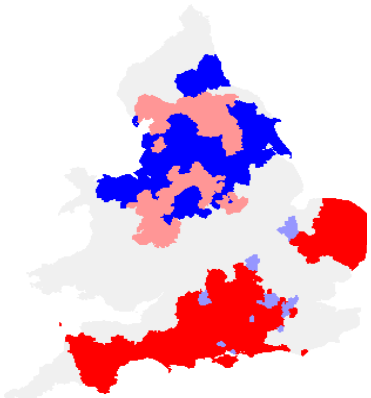
2007 I = 0.169 [0.000]



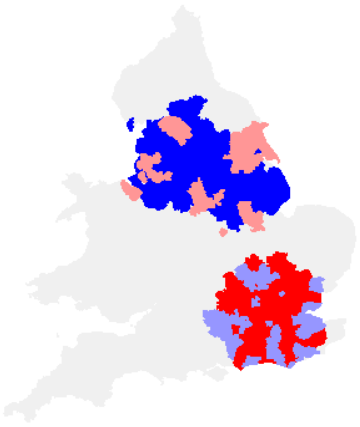
2008 I = 0.04 [0.006]



2009 I = 0.221 [0.000]

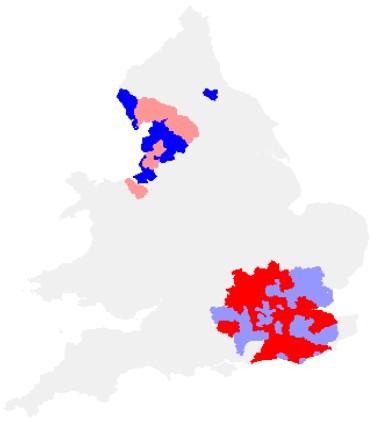


2010 I = 0.291 [0.000]

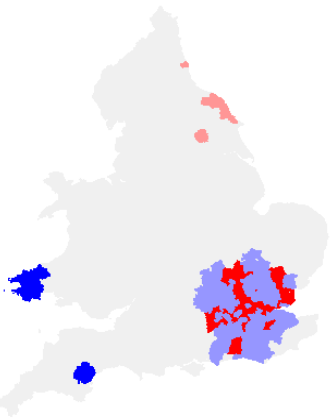


2011 I = 0.023 [0.030]

2012 I = 0.091 [0.001]



2013 I = 0.02 [0.020]



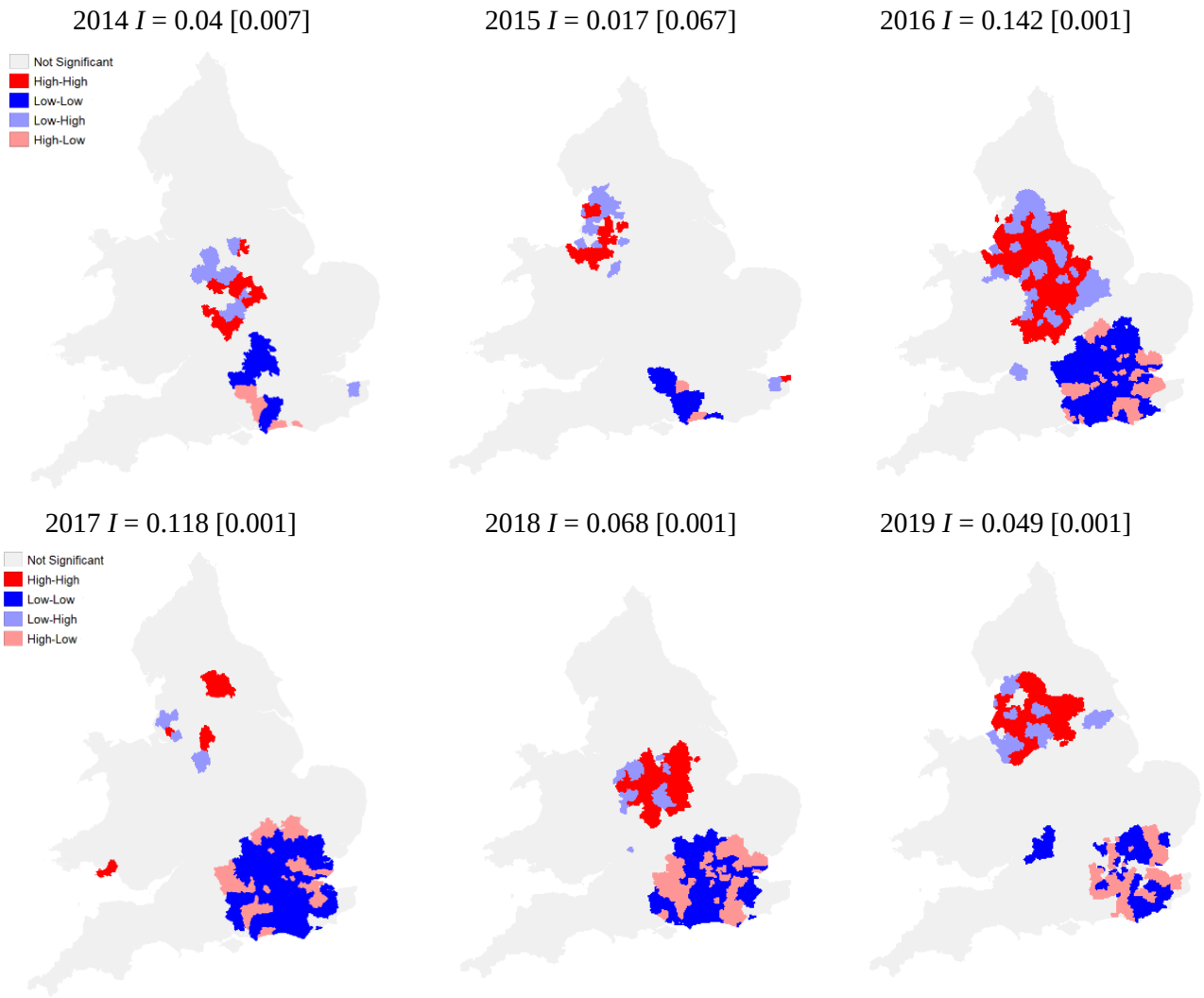


Figure 4. Annual LISA maps 1996 to 2019.

High coherence among Outer Metropolitan, Outer south east and London (Lo Cascio, 2021; Tsai, 2019) plus an error correction mechanism in affordability in London (Holmes and Otero, 2022) is suggestive of the possibility of the transmission of activity within extended hot and cold spots in the south. There are two eras, 1996 to 2000 and 2016 to 2019, amenable to consider intra-spot diffusion. In the first period, only Slough and Reading in the Outer Metropolitan region appear as part of a cluster of rapid growth districts for all five years. These would be indicative of activity-leader areas and fits with Gray's (2012) work. The hot spot does appear to be shrinking until 1998. It then expands again in 1999, only to be subject to a dramatic switch from a hot to a cold spot in the following year. In 1999, there are 77 HH and 34 LH classified districts in the extended London hot spot. A majority switch their classification, exchanging a high for a low growth grouping with around 10% changing the other way. Interestingly, the credit indicators, lending to corporates and base rates, moved in adverse directions for the housing market in 2000, which would affect the high price southern regions concurrently, as indicated in the serial correlation coefficient of −0.42, and perhaps more acutely than the north, explaining the switch from to relatively sluggish growth.

One would expect that the dissimilar cases would, through arbitrage, align with the general growth pattern after some delay. The London area cold spot in 2016 contains 108 districts. Of the 79 LL classified districts in 2016, 50 are so in 2018. It is the anomalies that are less stable. Of the 29 HL districts in 2016, 8 are so two years later whilst 18 switch to LL. In total, a quarter become unclassified. When the spot begins to atrophy in 2019 the majority of the classification in 2016 are not appropriate in 2019. Although it appears to remain a cold spot, the majority of the LL classifications are not retained, commonly becoming unclassified. This spot could have shrunk further with neighbouring areas becoming subject to weak activity, but the pandemic hit, preventing such analysis. However, atrophication is not the norm in the maps in Figure 4.

Meen's argument that common drivers explain movements in activity may be the most appropriate, given the patterns shown here. Change in lending conditions might have a more universal effect on overall activity than price. Maps appear to be similar over a number of years as cluster activity evolves. When maintaining the activity stimulated by price increases in combination with greater credit, Type 3 buyers would maintain an elevated level of activity for some time. The ripple effect in price could be a function of the markets most sensitive to credit, the higher priced one, responding in first and through price increases. The others could respond by adjustments in volume rather than price.

9. Missing movers

Hudson & Green (2017) outline three explanations for missing mortgage movers. First, the property equity is not rising rapidly enough to finance a move up the housing ladder. Second, the loan is not affordable and third, the loan is insufficient. Additionally, others have implied there were a raised number of participants before earlier bubbles burst. The swing in numbers would be consistent with a change in the participation of the Type 3 buyer. The reduced number of Type 3 participant applies to much of England and Wales as price grows more sluggishly. This buyer in the London area would have seen their equity rise out of line with the rest of the country, enhancing their equity, yet transactions in London grew more slowly than elsewhere. Holmes and Otero (2022) point out that decreasing affordability can moderate London's long-term unaffordability with rising prices; high prices deter purchase activity. The combination of affordability and loan size would be consistent with a credit constraint/risk appetite explanation. In real terms, the gap between the loan and house price in 2019 was much larger than it was in 1995. The Type 3 participant could require more that a rise in equity to participate.

10. Conclusions

This paper set out to explore whether housing activity diffuses across space as implied by the conventional price ripple effect. The maps show relatively elevated levels of housing activity over a number of years as cluster activity evolves. It is averred that the evolution of activity is related to participants being induced on to the market, stimulated by price increases in combination with greater credit. It is likely that the absence of such buyers is the cause the missing mortgage buyers (Hudson & Green, 2017) post 2007.

One cannot tract movement of a hot spot emanating from London, passing across neighbouring southern and midlands regions, ending up covering the north as a ripple effect might be described. Instead, there is a hot or cold spot that sits over an extended London area for some time, which jumps to float over other areas, commonly the north west. From this spatial correlation work, it does not appear as if there is a rippling of activity across large spaces. Meen's argument that common drivers explain movements in housing market activity may be the most appropriate of all the alternatives he presents. Credit supply could have a common impact on housing markets, but the ones most sensitive to credit, the higher priced ones, respond first and through price increases. The others could respond by adjustments in volume rather than price.

Benito and Wood (2005) find that households are two to three times more likely to purchase certain durable goods when they move home, reinforcing the link between housing and economic activity (Leamer, 2007). Although it appears as if London has pulled away from the other regions, housing market activity has generally exhibited sluggish growth since 2008, which would have negative implications for the UK's economic growth rate is subject to the same affliction. Although the theme here is that credit conditions drive economic activity, greater credit is not the answer to reduced housing activity. That will create the conditions for future bubble events. The continuing rise of the loan-to-income ratio suggests that more credit is heaped onto buyers, making housing less affordable. The demand side of the housing activity equation appears locked into an unsustainable trend. The housing provision itself must be addressed, which is an area beyond the scope of this paper.

Conflict of interest

The author declares no conflicts of interest in this paper.

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