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Differing House Price Linkages Across UK Regions: A Multi-Dimensional Recursive Ripple Model

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Abstract

The aim of this study is to determine the nature of the relationship between house prices of different types of housing across the UK regions. We use an ARDL bounds testing approach to determine the long-run relationships between house prices as well as an ECM to estimate the short-run dynamics between house prices. The data includes house prices across the regions of Great Britain and for new, old and modern houses. The results suggest that house price shocks ripple across regions, although the nature of the relationship varies across housing types. We further simulate the impact of house price shocks and reveal a complex structure whereby a house price shock in region A impacts upon prices in other regions, which in turn feedback into region A in a recursive ripple.

Keywords: recursive ripple effect, different house types. UK regions.

JEL: O18, P25, R31

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1. Introduction

The aim of this study is to determine whether house prices across different regions in the UK are related in terms of proximity and housing type. There is substantial evidence of an inter-relationship between housing in different regions within the UK and other countries, which is often termed the 'ripple effect'. This suggests that the effect of a shock on house prices in London ripples out to the other regions in the UK (Cook, 2006). Our study uses cointegration and error correction models (ECMs) to determine causal linkages between regions in the UK, whilst analysing the effect in terms of different property types, i.e. old, new and modern houses. Most analyses do not differentiate between house types. But if houses are not perfect substitutes, either because of spatial location or house type, this will impact upon the ripple. In particular a shock which affects old houses will have different dynamics to one that affects new houses.

The UK housing market has received a lot of attention in the literature recently, partly because of the importance of the housing market to the financial sector and subsequently its role in the 2008 financial crisis, and partly due to its importance as a wealth effect. The volatility in the UK housing market therefore has important repercussions for the stability of the financial system and wider economy, whilst the wealth effect has important implications for monetary policy. It is increasingly useful to understand more of the dynamics surrounding the UK housing market and how volatility changes across the UK.

New houses differ from older houses in being built with contemporary technologies and probably come with a warranty. New houses too, generally come with modern fitted kitchens and bathrooms and are also more energy efficient. However they tend to be smaller than older houses particularly with respect to gardens and parking spaces. Modern houses are those built since 1945[1] and share some of the built characteristics of new houses, tending to be smaller

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[1] Definition used by Nationwide.

and more energy efficient than older houses. There has been a substantial amount of work done on housing attributes and people's preferences for different house types (Mulder, 1996; Coolen and Hoekstra, 2001). In addition for urban housing in particular, age reflects location, as housing in the centre tends to be older than housing in the outer suburbs[2]. There is relatively little literature which explicitly analyses these different types of houses per se. However, there is some work on interactions between different house types (Cook and Holly, 2000; Cook, 2006; Narayan and Narayan, 2011; Gray, 2015). But none of this combines it with regional ripples.

This paper partially fills that gap. It primarily contributes to the literature by combining the interaction of the three different house types: old, modern and new in conjunction with the interrelationships between all neighbouring regions, not just with London as is more typical in this literature. We argue, similarly to Holly *et al.* (2011), that house prices are influenced by house prices in all neighbouring regions. This leads to what might be termed a 'multidimensional recursive ripple'. In other words, we consider the idea that price shocks are more likely to transmit to other regions across the UK via similar housing types. Since the advent of substantial capital inflows into the UK housing market over the recent past, most of which is to London, it has become increasingly important to determine how this effect on prices impacts regions outside London across the differing property types, and then the subsequent interaction between neighbouring regions. In this case a shock to new houses in, e.g., Outer Metropolitan, which surrounds London, impacts out to the South East to both new and other houses and then the rest of the country, but there are also impacts coming back to Outer Metropolitan following on from price changes in other regions. Each house type will have its own dynamic. In addition we use the ARDL approach to modelling the ripple effect for the UK

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[2] For a guide to how housing has changed over time see:
http://www.nhbc.co.uk/NewsandComment/Documents/filedownload,59849,en.pdf

for the first time, complementing the study by Payne (2012) who uses this approach for US house prices. The paper proceeds as follows. Following the introduction, literature review and theory sections, there is a section on the ARDL bounds testing approach used in this study. Then we discuss the data used and the results. Finally we conclude and offer some policy implications.

2. Literature Review

There is an extensive literature on how regional house prices interact through the 'ripple effect' and how they converge or diverge over time (Holmans, 1990; MacDonald and Taylor. 1993; Alexander and Barrow, 1994; Drake, 1995; Petersen *et al*., 2002). In general, many studies believe that London, and to a lesser extent the South East, are the primary drivers of house prices in the UK. Shocks emanating in these regions move northwards and westwards (Holmes and Grimes, 2008; Holmes, 2007; Cook and Watson, 2016). Drake (1995) finds evidence of convergence in most UK regional housing markets. His results imply that regional differentials vary across the UK. Although the literature tends to focus on London as the dominant region, there is also evidence that its effect is greatest for regions neighbouring London, but often declines as we move towards the UK's periphery (Cook and Watson, 2016).

Meen (1999)[3] notes that one implication of the ripple effect is the existence of a long-run constancy or stationarity in the ratio of house prices in different regions to aggregate UK house prices, and much of the work has focused on this. Meen (1999) and Petersen *et al* (2002) were unable to present evidence to support the above implication through standard econometric techniques; despite their assumption of the existence of such convergence. However, Cook (2003) does find evidence for convergence after allowing for underlying asymmetry in the

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[3] These studies used time series approaches, Holmes (2007) and Holmes and Grimes (2008) used panel data approaches, again mostly based on unit root testing.

adjustment process which varies between regions. Cook and Thomas (2003) pursue an alternative methodology — Friedman's non-parametric test of ranking and business cycle dating procedures — to verify their results of ripple effects. They also employ the business cycle dating techniques of Birchenhall *et al.* (2001). With the integration of the two approaches, they supply strong evidence that the changes of house prices occur earlier and more extensively in the South East of England than other regions.

A more recent study on UK regional house prices by Cook (2012) employs the notions of β-convergence and σ-convergence. β-convergence occurs when a series with a lower starting point experiences faster growth than those with a higher starting point, so that the series move together over time relative to their initial values, whilst σ-convergence is the narrowing of the cross-sectional spread of a number of series over time. Cook's work demonstrates there is β-convergence over the full sample of observations available and also cyclical sub-samples; however, the findings of σ-convergence fail to detect convergence, possibly as a result of its episodic nature. In the late 1980s and early 1990s, Ashworth and Parker (1997) have used the maximum likelihood VAR cointegration approach to estimate the determinants of house prices in the UK regions. They show strong structural similarities in house price determination across the UK, with cointegration for each region except Scotland and Northern Ireland.

Holly *et al*. (2011) construct a model which has similarities to ours in the sense that regional house prices are impacted upon by the unweighted average of house prices in regions they share a border with. In their model a shock from London emanates to the rest of the country via both its direct impact and impact on its neighbours and thence their neighbours. There is also an 'echo effect' whereby eventually the shock reverberates back to London.

Apart from testing UK regional house price convergence, there are similar studies on other economies. For example, Payne (2012) analyses the ripple effect and long-run convergence in U.S. regional house prices, also using the ARDL approach to cointegration. The results provide evidence in support of the ripple effect, although there are differences across the regional markets. However other studies, such as Barros *et al*. (2012) analyse co-movements between state house prices and the US aggregate price adopting a fractional integration and cointegration approach, but find little evidence of long-run relationships or the ripple effect[4]. Zhang and Morley (2014) find evidence of convergence and the ripple effect in China, whilst Chien (2010) using Taiwanese data find support for the hypothesis that there are ripple effects for each city in Taiwan except Taipei City.

Compared to the work on regional house price interactions there is, as already mentioned, relatively little work on interactions between house prices of different types, this work finds greater links between old and modern houses, than with either of these and new houses. Cook and Holly (2000) find old, modern and new house price series are very similar but with significant differences at the extremes of the cycle. They further conclude that there is a greater degree of substitutability between old and modern house prices. Gray (2015) using spectral analysis, finds evidence of a ripple in cycles from modern to older dwellings, and that modern and older housing vintages are similar to each other, but distinct from new houses. Cook (2006) finds that for older and modern housing, most UK regions exhibit significant deepness in the form of peaks being higher than troughs. For new housing, slightly less evidence of asymmetry is found. Balcilar *et al.* (2013) also find evidence of the ripple effect with disaggregated data for South Africa, using large, medium and small sized houses. Lean and Smyth (2013) using a panel approach find evidence for the ripple effect in Malaysia. Like this study, the house prices are disaggregated into five different housing types. The distinction based on vintage is just one that can be made, and other work has, e.g., differentiated between flats, terraced houses, semi-detached and detached houses (Morley and Thomas, 2016).

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[4] For a comprehensive analysis of the ripple effect across the US see Barros *et al*. (2012)

3. Theory

Our model is similar to Peek and Wilcox (2006) and Mankiw and Weil (1989), apart from the presence of neighbourhood variables. Demand for House type 1, e.g. modern houses, in region j is a function of own house price (P_{1j}), the prices of house types 2 and 3, in this case new and old houses, in region j and the prices of all house types in neighbouring regions. We assume a linear demand function for simplicity:

$$D_{1j} = \beta_0 + \beta_1 P_{1j} + \beta_2 P_{2j} + \beta_3 P_{3j} + \beta_4 P^N_{1j} + \beta_5 P^N_{2j} + \beta_6 P^N_{3j} + \varepsilon_{1j} \qquad (1)$$

where ε_{1j} is a white noise error term and the N superscript denote prices in the neighbouring region. Supply will just be a function of price in the region:

$$S_{1j} = \Upsilon_0 + \Upsilon_1 P_{1j} + \eta_{ij} \qquad (2)$$

where η_{ij} is also a white noise error term.

Price is then equal to:

$$P_{1j} = \{(\beta_0 - \Upsilon_0) + \beta_2 P_{2j} + \beta_3 P_{3j} + \beta_4 P^N_{1j} + \beta_5 P^N_{2j} + \beta_6 P^N_{3j} + (\varepsilon_{1j} - \eta_{ij})\}/(\Upsilon_1 - \beta_1) \qquad (3)$$

We anticipate that Υ_1 will be different for new houses, as these have to be built. For old and modern houses, Υ_1 reflects the response of existing home owners to increased prices from selling their home. An increase in the price the house sells for should make them more likely to put their house on the market. Being as they will in general need to purchase another house this will only lead to an increase in net supply as it relates to those with second homes, those seeking to migrate and uninhabited houses which are brought to the market. There are other differences and reflecting this, there is a substantial literature detailing the extent to which new houses differ to other property forms as noted in Coulson *et al.* (2016). In particular the new home premium, whereby new houses, which tend to be in better condition and have various warranties, can produce a higher price relative to similar but older properties. However it is a complex relationship, which varies over time and location. In addition new homes tend to be located away from city centres and can proxy differences in the environment and transport links. There are also other differences in attributes between old, modern and new houses with respect, e.g., to size. In this context we would expect old and new houses to be furthest apart, with buyers who strongly prefer the characteristics of an old house, relatively unlikely to choose a new house and vice versa. This, and other differences already noted, implies that the strongest links will be between old and modern house prices and the weakest between old and new, both within and between regions.

This model essentially describes a long-run equilibrium. It is a version of the migration model (Jones and Leishman, 2006; Meen, 1999) where migration creates a spatial arbitrage process across adjacent housing markets. However, as Jones and Leishman discuss, there are other explanations. The impact of the regional variables will depend upon a range of factors linking region j with its neighbours, for example, transport infrastructure. From this we might conclude that the impact of all other prices both within and between regions is positive, as an house price increase pushes house buyers towards house type 1 in region j. That is house prices represent ‘push factors’. However an increase in the price of a neighbouring region’s house prices may reflect an increase in the attractiveness of that region, relating to a range of factors including a reduction in local taxes, better national transport links and enhanced leisure facilities. An increase in house prices will then reflect a ‘pull factor’ for that region, and hence tend to drive down house prices in other regions. We would expect the strongest of the push effects to be between houses of the same type or in the same region. Thus the coefficients are least likely to be positive for neighbouring house prices of different types.

Summarising all of this, both the literature and the theory, in terms of testable hypotheses we have

H1: House prices respond to the prices of neighbouring regions, not just one dominant region.
H2: A house price shock to house type i will be associated with a positive impact on house type i prices in neighbouring regions.
H3A: A house price shock to house type i will be associated with a positive impact on other house type prices in neighbouring regions if push factors dominate..
H3B: A house price shock to house type i will be associated with a negative impact on other house type prices in neighbouring regions if pull factor dominates.
H4: A house price shock to house type i will be associated with a positive impact on other house types in the same region.
H5: The inter-house type effects will be weakest between new and old houses and strongest between old and modern.

4. Methodology

We will model this within the context of an Autoregressive Distributed Lag (ARDL) approach to cointegration (e.g., Pesaran *et al.,* 2001). This approach to modelling the long and short-run relationships between a set of variables has the advantage over other similar approaches in that it doesn't matter if the variables are I(0) or I(1), as if the test statistic lies above the upper bound, we can conclude that there is evidence of cointegration between the variables. In general terms this involves estimating the conditional error correction version of the ARDL (4,4) model for the regional house prices (p_1) *and* (p_2):

$$\Delta p_{1t} = \lambda_0 + \sum_{i=1}^{T} \lambda_1 \Delta p_{1t-i} + \sum_{i=1}^{T} \lambda_2 \Delta p_{2t-i} + \delta_1 p_{1t-1} + \delta_2 p_{2t-1} + u_t \tag{4}$$

We choose a maximum lag length T, of 4, as is fairly common with quarterly data (Pesaran and Pesaran, 2005), in part for reasons of degrees of freedom. This lag length is realised three times in the regressions. In none of these cases was a lag length of 5 optimal. We then ‘bounds test’ for the presence of a long-run relationship between the different house prices. The test involves an F-test on the joint null hypothesis that the coefficients on the level variables are jointly equal to zero (Pesaran *et al.*, 2001). The statistics have a non-standard distribution and depend on whether the variables are individually I(0) or I(1). Instead of the conventional critical values, this test involves two asymptotic critical value bounds, depending on whether the variables are I(0) or I(1) or a mixture of both. If the test statistic exceeds their respective upper critical values, then there is evidence of a long-run relationship.

The conditional long-run model can then be produced from the reduced form solution of equation (4), where the first-differenced variables are jointly equal to zero. Thus the long-run coefficients and short-run ECM are estimated using the ARDL approach to cointegration, in which the conditional ECM is estimated using OLS and then the Schwarz-Bayesian criteria is used to select the optimal lag structure for the ARDL specification of the short-run dynamics[5]. Our model is more complex than equation (4), in modelling the interaction between three different house types within a region and three in the average of neighbouring regions. Degrees of freedom limit our ability to include all neighbouring regional house prices for all house types in a regression model, hence, similar to Holly *et al* (2011), we group neighbouring regions into an average.

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[5] Apart from the North West for old houses where the Schwarz-Bayesian criteria failed to fit an ECM. In this case the Hannan-Quinn criteria was used.

5. Data and Results

Insert Figure 1 about here.

The regional quarterly data on all three house types are obtained from the Nationwide Building Society[6] for properties at the post survey approval stage for the time period 1973Q4-2014Q4. These are the same data used by Cook and Holly (2000), Cook (2006), Gray (2015) and Narayan and Narayan (2011). The regions are listed in Table 1. There was some missing data, mainly related to new houses. For the North there were ten periods missing, Yorkshire and Humberside 3, North West 1, East Midlands 1, West Midlands 3, East Anglia 5, London 9 and Wales 8. This missing data was linearly interpolated from adjacent data of the same house type in the same region. Figure 1 shows the three indices for the UK as a whole. As can be seen, the three price series are similar, but not the same and hence should be modelled separately. The figure also shows old house prices across several regions, as we move northwards from London. Again it can be seen that movements are similar, but that there are differences, e.g. the decline in prices in the early 1990s tended to be delayed and more muted, but the slowdown was then more prolonged, in the regions away from London.

Insert Table 1 about here.

Table 1 shows the correlations between the proportionate quarterly changes in house prices. In general we can see that between regions, the highest correlations are for houses of the same type. This strongly suggests that these are different, but related, house markets. However, this inter-regional correlation is weaker for new houses. This further suggests that the market for

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[6] http://www.nationwide.co.uk/about/house-price-index/download-data#xtab:regional-quarterly-series-all-properties-data-available-from-1973-onwards

new houses is different to that for other houses and is more linked to dynamics within the region than outside. The table also shows that the correlations tend to decline with distance, lending support to our basic assumption that house prices in region A are impacted upon by its neighbours, rather than what may be thought of as ‘the most important region’.

We first test for the order of integration of the data, in order to ensure none of the variables are I(2). Using the Philips and Perron test with a lag length of four, all logged house prices are I(1) at a 1% level of significance. With a 5% significance level, new houses in the North and Scotland are I(0). Using the augmented Dicky Fuller test, all variables are judged to be I(1) at the 5% level of significance[7]. Hence overall we conclude the variables are either I(0) or I(1) and suitable for analysis using the ARDL methodology.

Insert Table 2 about here.

Table 2 shows the results for new houses. The bounds test F statistic shows evidence of a long-run equilibrium relationship in 11 cases at the 1% level of significance and is inconclusive in one, Outer Metropolitan. These results are repeated in the regressions for modern houses in Table 3 where a significant long-run equilibrium relationship can be found in seven cases at the 1% level, four cases are inconclusive and there is no significant relationship in the South East. Finally in Table 4, for old houses there is evidence of a long-run equilibrium relationship in 10 cases at the 1% level, the test is inconclusive in one case and there is no significant relationship for Yorkshire and Humberside. In what follows, we model an error correction term for all the equations for two reasons. Firstly, it is significant in all but one case[8] and secondly in most cases the bounds test suggests cointegration. In doing this analysis, we modified the

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[7] Details on these tests can be obtained from the authors.

[8] The exception being for old houses in Yorkshire and Humberside, which is nearly significant at the 5% level.

neighbouring regions in two respects. Firstly, the regression results, not all of which are reported in the tables, suggest a closer relationship between London and a neighbourhood which, in addition to Outer Metropolitan includes the South East and East Anglia which border Outer Metropolitan, than with just Outer Metropolitan on its own. This is similar to the assumption made by Holly *et al*. (2011), and is not unreasonable as it is in many respects as easy to commute into London from these regions as it is from Outer Metropolitan. The correlations in Table 1 further suggest a close relationship between London and these two regions. Secondly, the regression results, again not all reported, suggested a stronger relationship between the North West and its neighbours when those excluded Scotland. The great majority of people in the North West live south of Preston and in Scotland the majority of people live north of Lanark. The road distance between these two locations is 160 miles.

The bottom part of Table 2 shows the long-run coefficients for new houses. For the West Midlands, none of the coefficients are significant at the 5% level, although there is cointegration at the 1% level of significance. In the ECM the error correction term is the only significant term at the 5% level. Thus for the West Midlands there is relatively little evidence of strong interrelationships between the different house price variables. This is however something of an exception. The next column relates to the East Midlands, where old and modern house prices are both significant at the 5% and 1% significance levels respectively in the long-run equation. The prices of all three types of houses in neighbouring regions are also all significant. In the ECM changes in new and modern house prices are both significant, the latter with a lag. Again all three types of neighbouring houses are significant with varying signs. In terms of prices within the region, modern house prices are frequently significant, but old house prices less frequently so. This is also true for neighbouring regions’ house prices. However the strongest impact is typically from new house prices in neighbouring regions.

Insert Table 3 about here.

Insert Table 4 about here.

Table 3 shows the results for modern houses. Old houses in the West Midlands are significant at the 1% level in the long-run equation, and neighbouring regions' modern house prices are significant in the ECM. Table 4 shows the results for old houses. Taking Scotland, we can see from the ECM, strong short-run impacts from modern houses and lagged old house prices. There is also a strong impact from neighbouring house prices, particularly of neighbouring old house prices. Comparing the different house types the most rapid adjustment to equilibrium is for old house prices with an average EC coefficient of -0.458. The average coefficients for new and modern houses respectively are -0.368 and -0.360. These results reflect those of Payne (2012) for the US housing market, who found variation in both the short and long-run changes in regional house prices over different regions, as well as differing speeds of adjustment in the ECMs. These vary from between 7 and 51% in Payne (2012) and 16 to 86% in this study.

In terms of the regions, the most rapid adjustment is in London and Outer Metropolitan, but also Wales and the North West, and the slowest adjustment is in the South West, Yorkshire and Humberside and East Anglia. We would expect the speed to be positively linked to population density. This is consistent with the argument by Clapp, Dolde and Tirtiroglu (1995), that information costs decline with the number of transactions in the housing area. Markets with a higher level of transactions should have lower information costs, and because of this prices should adjust more quickly to their long-run equilibrium value (Capozza *et al*., 2004). There is some evidence for this. The rank correlation between the speed of adjustment and population density in 2012 is -0.55 which is significant, with just twelve observations, at the

10% level. The main outlier is Wales which has rapid adjustment and low population density. Other factors also affect the speed of adjustment, such as the frequency with which people move houses. But it may also be relevant that about half the population of Wales live in the high population density area around Newport, Cardiff, and Swansea, which is reasonably close to Bristol and the West Midlands.

Insert Table 5 about here.

Table 5 summarises the impacts. Firstly with respect to the ECMs the coefficients on the lagged dependent variables are overwhelmingly significantly negative, indicating a degree of correction to a previous own house type, own-region shock. The remaining own-region short-run variables tend to have a positive coefficient when significant. The impacts of the neighbouring variables tend to be predominantly positive for own-house type when significant, which is generally the case. Non-own house type variables also tend to have positive coefficients when significant, although not for the impact of neighbouring old house prices on modern house prices and vice versa, where the impacts are predominantly negative. Turning to the long-run equations, the intra-region coefficients tend to be positive, particularly between old and modern house prices. The impact of the neighbouring variables are unambiguosly positive for own-house type and tend to be negative for non own-house types, particularly when relating to the interaction of old and modern house prices. This is consistent with the theory, where the latter reflects both pull and push factors.

We simulated the impact of a 1% permanent shock in turn for each house type in each region over a ten year period. The simulations were based on each set of individual ARDL results which underlie the results reported in Tables 2-4[9]. A shock to old house prices in Outer Metropolitan has its biggest impact upon old houses in London and thence the South East and the South West. There is a much smaller impact upon house prices in Scotland, the North West and, more surprisingly, East Anglia. This same pattern is repeated for a shock to modern houses with the impact being somewhat smaller. This is also true for new houses although the impact is smaller still and East Anglia is now not so immune. But shocks in other parts of the country can also have their impact. Thus a shock on modern houses in the West Midlands impacts fairly evenly throughout the country, although less so in the South East, Outer Metropolitan, London and East Anglia. There are some negative impacts consistent with neighbouring house prices reflecting pull factors.

We also estimated panel ARDL regressions using the pooled mean group estimator (PMG) proposed by Pesaran, Shin and Smith (1999). This permits short-run coefficients and the speed of adjustment to differ across countries, but imposes homogeneity on long-run coefficients. It also restricts the model to the same short-run lags across regions. For this reason, we have focused on separate ARDL regressions where different lag structures can be estimated. Nonetheless, the PMG estimates are consistent with those already discussed. Focusing first on the long-run equilibrium relationships, neighbouring old house prices are significantly negative in the modern house equation, and vice versa. Modern houses are related to both own region old and new house prices. But there is relatively little linkage between old and new house prices, either in the same or neighbouring regions. Finally, for all three house types, the neighbouring house type is most influenced by their own type. Turning to the short-run equations, the adjustment speeds for old, modern and new house prices at -0.223, -0.283 and -0.226 respectively, which are slightly lower than previously, and there are fewer lags in the optimal model. There are again no significant impacts between old and new houses in either of

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[9] Detailed results are available from the authors.

the two equations. However, changes in neighbouring house prices of the same vintage are significantly positive in all three short-run adjustment equations.

Insert Table 2 about here.

Finally we return to our original assumption that house prices are influenced by neighbouring regions' house prices and not simply by London. In Table 6 for the South East and East Anglia, we add to the specifications in Tables 2-4, house prices in Outer Metropolitan, which they both border and hence are also included in calculating neighbours' house prices. The table reports the F statistics for the significance of the two sets of coefficients from the ARDL model. For old house price in the South East, neighbouring house prices as a group, i.e. all three types of house prices with all current and lagged variables, are significant at the 1% level. Outer Metropolitan house prices as a group are also significant, although only at the 5% level of significance. In general this characterises the other five results for these two regions. Outer Metropolitan house prices are only more significant than neighbouring house prices for new house prices in the South East. The third set of rows reports the results of a similar exercise for Outer Metropolitan, with its neighbouring house prices together with those of London. The results are similar to those in the earlier rows, apart from new houses, where neighbouring house prices are not significant at even the 10% level. Thus overall, the basic assumption that house prices are influenced by all neighbouring regions house prices and not simply by London receives support. But the significance of the London variables suggests that neighbouring regions should not all have equal weights in calculating the average. This is to be expected, but degrees of freedom constrained us to use simple averages.

6. Conclusions

The results provide support for the several hypotheses we put forward. Firstly, house prices in the South East and East Anglia respond to the average prices of different house types in neighbouring regions and not just Outer Metropolitan, the dominant region. Similarly, house prices in Outer Metropolitan respond to prices in neighbouring regions as a whole rather than just London. This is consistent with H1, the migration based model we put forward, and with Holly *et al*. (2011). Secondly, overwhelmingly, positive shocks to house type i impact positively on the same house type prices in neighbouring regions, thus supporting H2. There is also a linkage with other types of houses in neighbouring regions. But the impact here is generally negative, rather than positive, particularly in the long-run equations as emphasised in Table 5. This is consistent with H3B. Fourthly, confirming H4, a positive shock to house type i tends to transmit to a positive shock to other house types in the same region. Again the evidence is strong for this. Finally, related to H5, these inter-house type effects are weakest between new and old houses and strongest between modern and old house prices. The latter is consistent with the results of Cook and Thomas (2015), Cook and Holly (2000) and Gray (2015). However, we also find a link, though slightly weaker, between modern and new houses. In this way, modern houses form a bridge by which shocks to new houses are transmitted to old houses and vice versa. This is in addition to shocks transmitted by the relatively weak direct links between old and new houses.

The work is also consistent with that of Holly *et al*. (2011) who argue that regional house prices are impacted upon by the unweighted average of house prices in regions they share a border with and it is via this mechanism that they are linked with other non-neighbouring regions including London. Because of this, policy changes and exogenous shocks can be expected to impact on different house types in different ways and with different dynamics. It also suggests that the diffusion of house price shocks across regions primarily takes place within the same house types. But there is also an impact from one house type to another. Hence, a positive shock to new houses in London and Outer Metropolitan, will first impact on the South East and thence on the South West, the West and East Midlands and East Anglia. There will then be further knock on effects on e.g. the North West, all with differing speeds. Initially the largest impacts will be on other house types in London and new houses in other regions. But the impact will eventually spread across all house types and regions. There will then be ripples, or echoes, back, from these regions to new houses in London. Hence the ripple acts recursively on at least two dimensions firstly the spatial dimension and secondly the house vintage dimension. In effect there are multi-dimensional recursive ripples between different house types both within the same region and between regions.

Further work could concentrate on distinguishing more clearly between the differences in housing stock 'types'. The data used has the limitation that the housing types are not more finely classified in terms of housing stock clusters and demander groups. The definitions used in this study are limited by the data availability. It could also be argued that the ripple effect is itself an artefact caused by the myriad differing regional economic structures in the UK, and differential timing of economic sectors to macro or international economic shocks. This argument could be extended to suggest that ripple effects are more apparent when broken down by stock type, due to the fact that each sub-type performs better at a different points in the economic cycle. The definition used in this study of house type is based on age, further research could be done on other definitions such as flats, terraced, detached houses etc. Possibly the divisions between markets may be still stronger than in our analysis. Our work has also assumed all neighbours have equal influence, this is something which could be relaxed in future work.

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Table 1: Correlation matrix of house prices across regions and house types.

	OWM	NWM	MWM	OEM	NEM	MEM	OSW	NSW	MSW	ONW	NNW	MNW	OLN	NLN	MLN	ON	NN	MN	OYH	NYH	MYH	OEA	NEA	MEA	OSC	NSC	MSC	OWA	NWA	MWA	OSE	NSE	MSE	OOM	NOM
NWM	0.20*	1.00																																	
MWM	0.35*	0.11	1.00																																
OEM	0.85*	0.09	0.42*	1.00																															
NEM	0.13	-0.02	0.45*	0.22*	1.00																														
MEM	0.28*	0.16*	0.79*	0.29*	0.43*	1.00																													
OSW	0.78*	0.13	0.33*	0.83*	0.16*	0.21*	1.00																												
NSW	0.23*	0.15*	0.51*	0.18*	0.18*	0.49*	0.21*	1.00																											
MSW	0.38*	0.12	0.80*	0.38*	0.45*	0.73*	0.38*	0.49*	1.00																										
ONW	0.85*	0.14	0.37*	0.84*	0.12	0.22*	0.76*	0.23*	0.31*	1.00																									
NNW	0.15*	0.09	0.29*	0.10	0.23*	0.27*	0.00	0.11	0.24*	0.16*	1.00																								
MNW	0.22*	0.11	0.64*	0.18*	0.39*	0.65*	0.13	0.37*	0.55*	0.26*	0.45*	1.00																							
OLN	0.71*	0.17*	0.21*	0.71*	0.16*	0.17*	0.79*	0.22*	0.23*	0.66*	0.04	0.09	1.00																						
NLN	-0.02	-0.06	0.10	0.06	0.09	0.03	0.04	-0.09	0.12	-0.07	0.18*	0.14	-0.01	1.00																					
MLN	0.20*	0.13	0.51*	0.25*	0.29*	0.43*	0.27*	0.30*	0.54*	0.13	0.30*	0.44*	0.18*	0.43*	1.00																				
ON	0.67*	0.20*	0.23*	0.67*	0.07	0.10	0.62*	0.23*	0.19*	0.73*	0.08	0.13	0.51*	-0.13	0.14	1.00																			
NN	0.04	0.04	0.11	0.12	0.17*	0.16*	0.05	0.06	0.15	0.14	0.07	0.08	0.02	-0.03	0.02	-0.01	1.00																		
MN	0.19*	0.05	0.41*	0.20*	0.24*	0.47*	0.16*	0.13	0.38*	0.28*	0.28*	0.59*	0.05	-0.02	0.25*	0.10	0.30*	1.00																	
OYH	0.81*	0.25*	0.39*	0.82*	0.08	0.25*	0.72*	0.24*	0.37*	0.81*	0.07	0.17*	0.58*	-0.04	0.20*	0.77*	0.10	0.17*	1.00																
NYH	0.22*	-0.03	0.30*	0.28*	0.42*	0.35*	0.23*	0.14	0.31*	0.22*	0.22*	0.39*	0.14	0.27*	0.32*	0.12	0.05	0.25*	0.14	1.00															
MYH	0.30*	0.21*	0.62*	0.28*	0.40*	0.65*	0.24*	0.38*	0.54*	0.23*	0.31*	0.64*	0.17*	0.14	0.48*	0.23*	0.07	0.46*	0.29*	0.41*	1.00														
OEA	0.78*	0.16*	0.29*	0.73*	0.09	0.20*	0.82*	0.25*	0.35*	0.72*	0.03	0.14	0.76*	0.01	0.20*	0.57*	0.11	0.12	0.69*	0.19*	0.27*	1.00													
NEA	0.03	-0.05	0.35*	0.10	0.43*	0.30*	0.12	0.27*	0.38*	0.03	0.21*	0.27*	0.01	0.29*	0.35*	-0.03	0.10	0.14	-0.03	0.24*	0.24*	0.10	1.00												
MEA	0.35*	0.09	0.65*	0.37*	0.46*	0.67*	0.34*	0.37*	0.73*	0.30*	0.24*	0.53*	0.21*	0.14	0.53*	0.17*	0.15	0.43*	0.27*	0.36*	0.47*	0.35*	0.38*	1.00											
OSC	0.66*	0.14	0.23*	0.65*	0.03	0.13	0.73*	0.19*	0.20*	0.76*	0.01	0.11	0.62*	-0.07	0.10	0.69*	0.06	0.17*	0.74*	0.09	0.19*	0.61*	-0.10	0.14	1.00										
NSC	0.25*	0.11	0.26*	0.16*	0.10	0.27*	0.09	0.19*	0.15	0.26*	0.21*	0.33*	0.17*	-0.07	0.11	0.17*	-0.13	0.21*	0.17*	0.14	0.24*	0.09	0.00	0.23*	0.16	1.00									
MSC	0.26*	0.07	0.44*	0.22*	0.12	0.43*	0.16*	0.28*	0.37*	0.33*	0.38*	0.62*	0.13	0.05	0.36*	0.22*	0.12	0.53*	0.23*	0.28*	0.48*	0.17*	0.17*	0.38*	0.27*	0.35*	1.00								
OWA	0.81*	0.16*	0.40*	0.80*	0.12	0.21*	0.65*	0.18*	0.29*	0.78*	0.20*	0.20*	0.58*	0.02	0.24*	0.66*	-0.03	0.16*	0.77*	0.23*	0.26*	0.64*	0.00	0.30*	0.62*	0.28*	0.36*	1.00							
NWA	0.11	0.00	0.18*	0.16*	0.24*	0.02	0.14	0.20*	0.18*	0.11	0.23*	0.26*	0.08	0.52*	0.42*	0.14	-0.02	0.07	0.07	0.22*	0.28*	0.18*	0.30*	0.23*	0.03	0.02	0.22*	0.21*	1.00						
MWA	0.22*	-0.08	0.46*	0.19*	0.26*	0.47*	0.16*	0.27*	0.45*	0.27*	0.31*	0.58*	0.00	0.10	0.26*	0.10	0.14	0.46*	0.14	0.23*	0.43*	0.16*	0.30*	0.44*	0.13	0.10	0.41*	0.16*	0.25*	1.00					
OSE	0.79*	0.15	0.36*	0.81*	0.15	0.27*	0.91*	0.26*	0.41*	0.76*	-0.04	0.13	0.84*	-0.04	0.23*	0.61*	0.09	0.17*	0.70*	0.21*	0.27*	0.86*	0.11	0.36*	0.67*	0.15*	0.15*	0.64*	0.07	0.18*	1.00				
NSE	0.17*	0.06	0.41*	0.18*	0.27*	0.43*	0.18*	0.27*	0.53*	0.11	0.22*	0.35*	0.04	0.22*	0.43*	0.04	0.10	0.28*	0.09	0.21*	0.35*	0.16*	0.38*	0.52*	-0.05	0.13	0.23*	0.08	0.25*	0.46*	0.21*	1.00			
MSE	0.27*	0.13	0.69*	0.27*	0.40*	0.72*	0.34*	0.42*	0.81*	0.24*	0.14	0.55*	0.20*	0.06	0.65*	0.14	0.20*	0.46*	0.24*	0.26*	0.52*	0.32*	0.36*	0.77*	0.14	0.08	0.38*	0.18*	0.17*	0.50*	0.39*	0.55*	1.00		
OOM	0.76*	0.15	0.30*	0.78*	0.23*	0.23*	0.88*	0.18*	0.37*	0.76*	-0.03	0.13	0.86*	0.00	0.23*	0.55*	0.14	0.16*	0.67*	0.24*	0.23*	0.82*	0.08	0.36*	0.67*	0.10	0.13	0.60*	0.06	0.17*	0.92*	0.16*	0.37*	1.0	
NOM	0.14	0.09	0.21*	0.05	0.14	0.28*	0.15*	0.19*	0.34*	0.08	0.11	0.21*	0.12	0.14	0.37*	0.05	0.14	0.08	0.06	0.18*	0.21*	0.12	0.18*	0.22*	0.08	-0.06	0.19*	0.02	0.10	0.16*	0.13	0.07	0.39*	0.18*	1.00
MOM	0.22*	0.14	0.57*	0.20*	0.39*	0.58*	0.24*	0.41*	0.63*	0.16*	0.19*	0.43*	0.25*	0.17*	0.59*	0.16*	0.13	0.21*	0.19*	0.20*	0.47*	0.26*	0.31*	0.57*	0.14	0.10	0.37*	0.22*	0.24*	0.25*	0.28*	0.36*	0.69*	0.30*	0.54
	OWM	NWM	MWM	OEM	NEM	MEM	OSW	NSW	MSW	ONW	NNW	MNW	OLN	NLN	MLN	ON	NN	MN	OYH	NYH	MYH	OEA	NEA	MEA	OSC	NSC	MSC	OWA	NWA	MWA	OSE	NSE	MSE	OOM	NOM

Notes: First letter denotes New (N), Modern (O) or old (O) house type. The remaining letters relate to the region, WM = West Midlands, EM=East Midlands, SW = South West, NW=North West, LN= London, OM=Outer Metropolitan, N=North. YH = Yorkshire & Humberside, EA=East Anglia, SC=Scotland, WA=Wales, SE=Outer South East.

Table 2: New Houses

	W Mids	E Mids	SW	NW	London	North	Y&H	E Anglia	Scotland	Wales	Outer SE	Outer Met.
ECM: Short-run Coefficients												
New lag 1		-0.459**	-0.45**	-0.228**			-0.297**	-0.192*			-0.285**	-0.362**
		(6.03)	(5.56)	(3.28)			(3.96)	(2.52)			(3.61)	(4.96)
Lag 2		-0.259**	-0.166*								-0.168*	
		(3.73)	(2.33)								(2.26)	
Lag 3			-0.295**									
			(4.85)									
Old		0.180*	-0.021	-0.122	-0.1775	-0.435*	-0.0236	0.032	0.0072	-0.103	-0.028	-0.097
		(2.03)	(0.26)	(1.05)	(0.86)	(2.14)	(0.24)	(0.46)	(0.10)	(0.64)	(0.21)	(0.80)
Lag 1					-0.522**							
					(3.88)							
Modern	-0.117	-0.104	0.0397	0.513**	1.323**	1.052	0.466**	0.533**	0.33**	0.51*	0.185	0.67**
	(0.66)	(0.75)	(0.41)	(3.98)	(4.51)	(0.27)	(2.88)	(3.77)	(3.99)	(2.51)	(1.40)	(5.24)
Lag 1		0.568**						0.344**		0.358*		
		(5.45)						(3.11)		(2.31)		
Lag 2		0.238*								-0.514**		
		(2.31)								(3.36)		
Neighbour												
Old	0.182	-0.227*	0.031	0.0534	0.164	0.299	0.0734	-0.0312	0.0034	0.165	0.007	0.0368
	(0.78)	(2.34)	(0.30)	(0.52)	(0.62)	(1.67)	(0.64)	(0.28)	(0.04)	(0.80)	(0.05)	(0.33)
Lag 1				0.194**					0.151**			
				(3.95)					(2.98)			
New	0.17	0.215**	0.154**	0.119*	0.649*	0.490	0.197**	0.528**	-0.106*	0.365**	0.048	0.04
	(1.63)	(3.72)	(3.77)	(2.52)	(2.41)	(1.89)	(3.28)	(5.59)	(2.45)	(2.85)	(0.46)	(0.68)
Modern	0.224	0.618**	0.768**	0.032	-0.756*	-0.357	-0.033	-0.313*	0.217**	-0.146	0.456*	0.051
	(1.02)	(4.27)	(4.98)	(0.21)	(1.98)	(1.04)	(0.22)	(2.17)	(2.62)	(0.54)	(2.27)	(0.31)
Lag 1			0.508**								0.389*	0.369**
			(3.81)								(2.49)	(2.96)
Lag 2											0.454**	
											(3.23)	
ECM	-0.514**	-0.292**	-0.168**	-0.300**	-0.437**	-0.441**	-0.339**	-0.42**	-0.252**	-0.479**	-0.276**	-0.404**
	(7.45)	(5.37)	(2.73)	(5.90)	(6.94)	(6.67)	(4.86)	(5.75)	(5.48)	(6.42)	(4.78)	(5.01)
$\bar{R}_2$	0.247	0.548	0.518	0.435	0.437	0.27	0.434	0.435	0.294	0.341	0.487	0.545

Long-run Coefficients												
Old	-0.001	0.616*	-0.125	-0.411	1.197*	-0.988*	-0.0639	0.075	0.0286	-0.214	-0.102	-0.242
	(0.00)	(2.00)	(0.25)	(1.02)	(2.16)	(2.19)	(0.24)	(0.45)	(0.10)	(0.67)	(0.21)	(0.75)
Modern	-0.228	-1.72**	0.237	1.734**	0.970	0.95	0.312	0.485*	1.312**	0.368	0.671	1.66**
	(0.66)	(4.23)	(0.38)	(4.68)	(1.48)	(1.82)	(0.83)	(2.05)	(3.28)	(0.97)	(1.28)	(3.98)
Neighbour												
Old	0.355	-0.779*	0.185	-0.867	0.375	1.1113	0.216	-0.074	-1.122**	0.346	0.0263	0.091
	(0.78)	(2.26)	(0.28)	(1.74)	(0.61)	(1.90)	(0.63)	(0.28)	(2.94)	(0.81)	(0.05)	(0.33)
New	0.331	0.738**	0.917**	0.401**	0.102	0.679	0.579**	1.257**	-0.479	0.762**	1.421**	0.099
	(1.68)	(4.84)	(2.84)	(3.07)	(0.26)	(1.75)	(4.23)	(7.02)	(0.33)	(3.08)	(5.72)	(0.72)
Modern	0.435	2.12**	-0.108	0.108	-1.728	-0.811	-0.099	-0.744*	0.861*	-0.305	-1.031	-0.645
	(1.04)	(4.33)	(0.13)	(0.20)	(1.93)	(1.05)	(0.22)	(2.39)	(2.28)	(0.54)	(1.66)	(1.91)
Constant	1.33**	0.206	-1.133	0.261	0.642	0.674	0.797	-0.071	-0.277	0.441	0.151	0.438*
	(3.09)	(0.68)	(1.82)	(0.85)	(1.12)	(0.90)	(0.80)	(0.28)	(0.48)	(1.09)	(0.52)	(2.20)
Bounds Test	9.66**	4.11**	4.31**	6.87**	7.83**	7.15**	5.64**	6.10**	5.50**	8.33**	5.79**	3.21[a]

Notes: (.) denotes the t statistics of the respective coefficients. */** indicates significance at 5%/1% levels respectively. The bounds test indicates cointegration in the long-run model. [a] indicates the test is inconclusive. A joint test for the significance of the long-run coefficients is significant at the 1% level in all regressions. The dependent variable is the change in the house prices, in the ECM model the short-run coefficients relate to the changes in the variables. All variables are logged.

Table 3: Dependent variable: Modern Houses

	W Mids	E Mids	SW	NW	London	North	Y&H	E Anglia	Scotland	Wales	Outer SE	Outer Met.	
ECM: Short-run Coefficients													
Modern													
lag 1	-0.212**		-0.21*		-0.027	-0.205**		-0.251**		-0.333**	-0.058	0.153**	
	(3.13)		(2.56)		(0.44)	(2.91)		(3.39)		(4.39)	(1.17)	(2.81)	
Lag 2					-0.236**						0.169**		
					(4.68)						(3.88)		
New	0.006	-0.071*	0.016	0.087**	0.084**	0.079**	0.126**	0.120**	0.031	0.071**	0.049	0.208**	
	(0.44)	(2.48)	(0.56)	(3.65)	(4.95)	(4.48)	(3.40)	(3.70)	(1.16)	(2.71)	(1.56)	(5.82)	
Lag 1							0.115**						
							(3.52)						
Old	0.061	0.113*	0.044	0.156**	0.228**	0.055	0.286**	0.043	0.087*		0.246**	0.162*	
	(1.28)	(2.42)	(1.12)	(2.90)	(4.51)	(1.11)	(6.65)	(1.19)	(2.20)		(4.73)	(2.20)	
Lag 1		0.045											
		(1.81)											
Lag 2		0.099**											
		(4.94)											
Neighbour													
Modern	0.811**	0.979**	0.808**	0.703**	0.653**	0.722**	0.541**	0.748**	0.436**	0.771**	0.862**	0.611**	
	(12.89)	(15.73)	(11.54)	(11.26)	(8.10)	(6.61)	(9.03)	(8.60)	(6.96)	(6.05)	(13.27)	(8.39)	
Lag 1	0.423**		0.35**	0.200**				0.282**		0.273			
	(5.00)		(4.47)	(3.32)				(2.78)		(1.94)			
Lag 2	-0.135**									0.375**			
	(2.36)									(3.28)			
New	0.006	0.031	0.042	-0.061**	0.160*		0.073	0.011	-0.115*	-0.009	-0.124**	0.076*	0.03
	(0.44)	(1.01)	(1.94)	(2.96)	(2.23)		(0.85)	(0.37)	(2.36)	(0.53)	(2.65)	(2.31)	(1.12)
Lag 1					0.264**	0.162*							
					(4.09)	(2.24)							
Lag 2						0.258**							
						(3.85)							
Lag 3						0.268**							
						(4.01)							
Old	0.069	-0.113*	0.064	-0.226**	-0.138**	-0.046	-0.273**	0.016	0.02	-0.262**	-0.203**	-0.003	
	(1.36)	(2.22)	(1.20)	(4.18)	(3.40)	(0.77)	(5.37)	(0.27)	(0.446)	(3.29)	(3.56)	(0.05)	

ECM	-0.239**	-0.33**	-0.156**	-0.354**	-0.510**	-0.296**	-0.548**	-0.249**	-0.232**	-0.35**	-0.286**	-0.86**
	(6.66)	(5.25)	(3.12)	(5.82)	(8.76)	(5.27)	(11.52)	(4.32)	(4.84)	(4.43)	(5.15)	(9.71)
$\bar{R}_2$	0.78	0.77	0.74	0.755	0.75	0.57	0.661	0.653	0.5	0.53	0.81	0.73
Long-run Coefficients												
New	0.024	-0.214**	0.102	0.245**	0.014	0.099	-0.002	0.48**	0.134	0.204*	0.862**	0.140**
	(0.44)	(2.81)	(0.51)	(4.47)	(0.43)	(1.75)	(0.03)	(3.41)	(1.23)	(2.44)	(8.67)	(2.97)
Old	1.21**	0.296*	0.28	0.441**	0.883**	0.185	0.522**	0.172	0.374**	0.588**	-0.13	0.583**
	(12.22)	(2.22)	(1.14)	(3.72)	(4.38)	(1.21)	(6.49)	(1.38)	(2.86)	(5.68)	(1.55)	(8.80)
Neighbour												
Old	-0.409	-0.342*	0.405	-0.638**	-0.845**	-0.156	-0.498**	0.066	0.088	-0.748**	-0.712**	-0.232**
	(1.89)	(2.46)	(1.11)	(4.71)	(5.38)	(0.78)	(5.08)	(0.26)	(0.43)	(3.84)	(5.22)	(3.24)
New	0.048	0.093	0.269	-0.171**	-0.332**	-0.359*	0.02	-0.461*	-0.04	-0.355*	0.265*	0.039
	(0.60)	(1.03)	(1.81)	(2.93)	(4.71)	(2.53)	(0.36)	(2.11)	(0.52)	(2.22)	(2.12)	(1.13)
Modern	0.150	1.138**	-0.104	1.162**	1.282**	1.205**	0.987**	0.739**	0.358	1.298**	0.701**	0.455**
	(0.70)	(6.18)	(0.21)	(9.05)	(8.95)	(5.35)	(10.90)	(3.16)	(1.84)	(5.11)	(4.82)	(6.85)
Constant	-0.231	0.251	0.552	-0.406**	-0.159	0.253	-0.325**	0.018	0.972**	0.158	0.187	0.193**
	(1.06)	(1.84)	(1.38)	(4.07)	(1.32)	(1.02)	(2.65)	(0.08)	(3.11)	(0.76)	(1.60)	(3.02)
Bounds Test	7.98**	4.72**	2.81^{a}	2.76^{a}	7.73**	7.27**	8.86**	2.58^{a}	4.01**	3.26^{a}	1.93	17.09**

Notes: See Table 2

Table 4: Dependent variable: Old House Price

	W Mids	E Mids	SW	NW	London	North	Y&H	E Anglia	Scotland	Wales	Outer SE	Outer Met
ECM: Short-run Coefficients												
Old lag 1			-0.568**	-0.162*	-0.214**	-0.467**	-0.641**	-0.542**	-0.309**			-0.359**
			(6.88)	(2.27)	(4.432)	(6.50)	(6.83)	(7.27)	(4.59)			(4.99)
Lag 2			-0.155**			-0.18**	-0.397**	-0.249**				
			(3.26)			(4.19)	(4.78)	(3.48)				
Lag 3							-0.146**					
							(3.67)					
New	0.0043	0.145**	0.067	-0.048	-0.034	0.051*	0.031	0.044	0.006	0.005	0.053*	-0.004
	(0.20)	(3.18)	(1.52)	(1.44)	(1.27)	(2.51)	(0.79)	(0.79)	(0.13)	(0.14)	(2.05)	(0.12)
Lag 1					0.098**			0.191**				
					(3.44)			(3.59)				
Lag 2					-0.069*							
					(2.56)							
Modern	0.261$^{**`}$	0.304**	0.167	0.314**	0.459**	0.012	0.366**	0.326**	0.479**	-0.22**	0.264**	0.227**
	(4.28)	(3.10)	(1.66)	(3.02)	(4.51)	(0.12)	(3.82)	(4.13)	(5.57)	(2.73)	(2.86)	(3.18)
Lag 1			0.509**	-0.230*	0.115		0.006			-0.052	-0.505**	
			(4.77)	(2.57)	(1.37)		(0.07)			(0.74)	(5.18)	
Lag 2			0.313**		0.391**		0.041			-0.255**		
			(3.09)		(5.11)		(0.51)			(3.70)		
Lag 3							0.281**					
							(3.74)					
Neighbour												
Old	0.828**	0.885**	0.942**	0.861**	0.929**	0.762**	0.952**	1.063**	0.734**	0.838**	0.922**	0.805**
	(16.18)	(17.37)	(16.66)	(19.24)	(15.79)	(11.50)	(18.25)	(16.04)	(12.20)	(11.23)	(26.96)	(21.62)
Lag 1				0.283**		0.374**	0.513**	0.427**	0.300**			0.387**
				(4.09)		(4.22)	(5.20)	(4.66)	(4.50)			(5.70)
Lag 2							0.265**	0.216*	0.131**			
							(3.12)	(2.53)	(2.78)			
New	-0.019	-0.12*	0.0255	-0.030	0.040	-0.09	-0.028	0.012	-0.0476	0.009	-0.034	-0.005
	(0.57)	(2.45)	(0.75)	(1.03)	(0.71)	(0.80)	(0.79)	(0.16)	(1.70)	(0.16)	(0.84)	(0.18)
Lag 1						0.341**						
						(3.37)						
Modern	-0.184*	-0.422**	-0.377**	-0.247*	-0.460**	0.127	-0.132	-0.19	-0.19*	0.228	-0.202	-0.13

	(2.33)	(3.36)	(3.28)	(2.44)	(3.49)	(1.06)	(1.27)	(1.47)	(2.51)	(1.39)	(1.81)	(1.92)
Lag1											0.463**	
											(4.28)	
ECM	-0.41**	-0.693**	-0.239**	-0.742**	-0.459**	-0.351**	-0.161	-0.219**	-0.381**	-0.796**	-0.622**	-0.422**
	(5.52)	(9.87)	(3.36)	(8.36)	(5.25)	(4.97)	(1.95)	(4.65)	(6.17)	(11.49)	(9.62)	(5.60)
$\bar{R}_2$	0.83	0.87	0.86	0.904	0.86	0.808	0.871	0.844	0.761	0.803	0.936	0.91
Long-run Coefficients												
New	0.0105	0.209**	0.282	-0.065	0.193**	-0.146**	0.191	-0.28	0.015	-0.211**	0.085*	-0.011
	(0.20)	(3.07)	(1.66)	(1.40)	(3.22)	(2.48)	(0.75)	(1.08)	(0.13)	(4.96)	(2.10)	(0.12)
Modern	0.636**	0.939**	-0.06	0.840**	0.517**	0.643**	0.486	1.487**	1.256**	1.110**	0.933**	0.943**
	(8.16)	(7.70)	(1.64)	(9.31)	(2.92)	(3.90)	(1.06)	(4.15)	(6.72)	(15.72)	(16.43)	(5.94)
Neighbour												
Old	0.804**	0.677**	2.256**	0.592**	1.182*	0.226	1.229*	2.582**	0.396*	0.629**	0.843**	0.414**
	(5.28)	(6.74)	(3.94)	(5.71)	(5.09)	(0.80)	(1.97)	(4.46)	(2.09)	(4.69)	(10.00)	(3.63)
New	-0.0456	-0.173*	0.106	-0.040	0.087	-0.002	-0.174	0.053	-0.125	0.012	-0.054	-0.0127
	(0.57)	(2.41)	(0.72)	(1.04)	(0.74)	(0.01)	(0.77)	(0.16)	(1.69)	(0.17)	(0.85)	(0.18)
Modern	-0.449**	-0.609**	-1.576**	-0.336*	-1.001**	0.361	-0.819	-2.948**	-0.499**	-0.537**	-0.789**	-0.313*
	(2.69)	(3.41)	(2.63)	(2.44)	(3.71)	(1.01)	(1.21)	(3.92)	(2.60)	(2.82)	(6.64)	(2.06)
Constant	0.508	-0.551**	0.081	-0.019	0.483*	-1.103**	1.229*	1.271*	-0.405	-0.105	-0.236**	-0.206
		(5.52)	(0.19)	(0.21)	(2.11)	(4.45)	(1.97)	(2.14)	(1.31)	(0.81)	(2.76)	(1.59)
Bounds Test	6.49**	14.94**	3.38[a]	12.05**	4.89**	4.03**	0.87	5.72**	7.01**	22.97**	15.99**	5.95**

Notes: See Table 2

Table 5: Summarising the Impacts

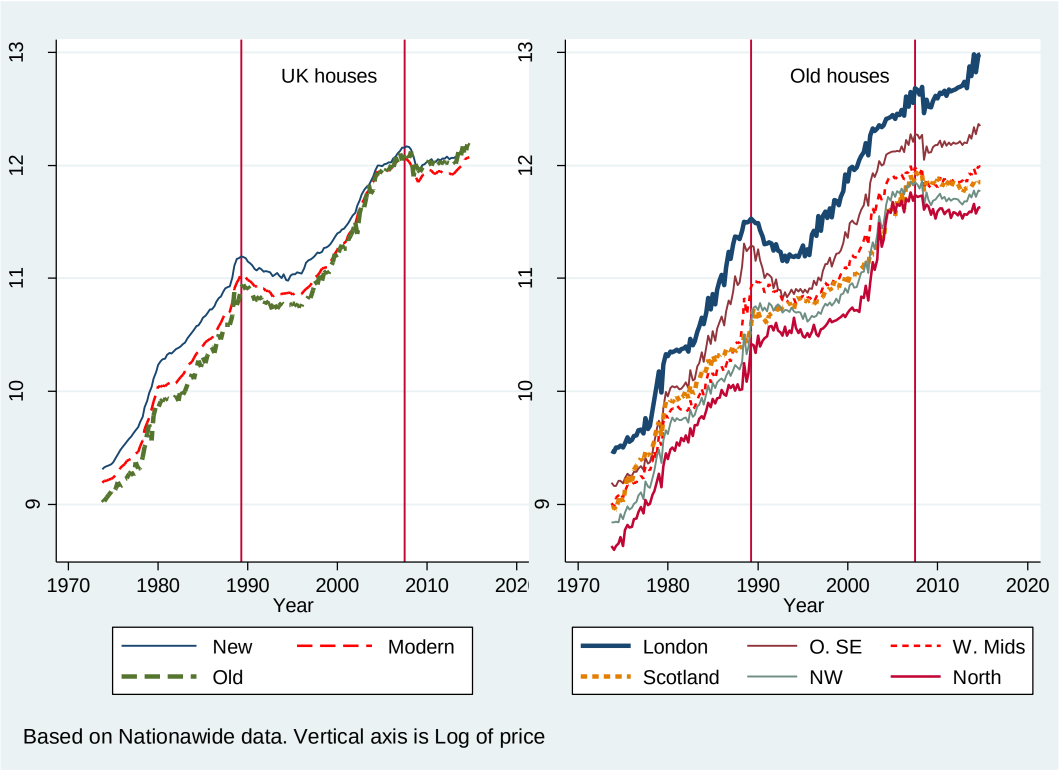
Equation:	Old	Modern	New
ECM Short-Run Coefficients			
Intra-region	+ : -	+ : -	+ : -
Old no Lag		7: 0	1: 1
Old lag	0: 13	1: 0	0: 1
Modern no lag	9: 1		7: 0
Modern lag	4: 3	1: 7	4: 1
New no lag	3: 0	7: 1	
New lagged	2: 1	1: 0	0: 11
Neighbouring regions			
Old no lag	12: 0	0: 6	0: 1
Old lagged	9: 0	0: 0	2: 0
Modern	0: 6	12: 0	4: 2
Modern lagged	1: 0	5: 1	4: 0
New	0: 1	2: 3	7: 1
New lagged	1: 0	4: 0	0: 0
Long-Run Coefficients			
	Old Houses	Modern Houses	New Houses
Intra-region			
Old		8: 0	2: 1
Modern	10: 0		4: 1
New	3: 2	5: 1	
Neighbouring regions			
Old	11: 0	0: 7	0: 2
Modern	0: 10	9: 0	2: 1
New	0: 1	1: 5	7: 0

Notes: These relate to the number of significant positive and then negative coefficients in Tables 2-4.

Table 6: The significance of neighbour and London variables in an expanded ARDL

	Independent Variable Groups:		
Dependent Variables:	*Neighbours*	*Outer Metropolitan*	*London*
South East			
Old	24.751***	3.015**	
Modern	22.806***	6.113***	
New	2.243*	6.100***	
East Anglia			
Old	11.329***	3.309**	
Modern	21.558***	8.955***	
New	13.814***	2.430*	
Outer Metropolitan			
Old	29.379***		7.000***
Modern	9.363***		6.401***
New	0.913		5.241***

Notes: First row shows the significance [F statistic] of all neighbour variables and all Outer Metropolitan variables in explaining old house prices in the South East when included jointly in an ARDL regression. */**/*** indicates significance at 10%/5%/1% levels respectively



Based on Nationawide data. Vertical axis is Log of price

Figure. 1 House prices across types and regions