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UK House Price Convergence Clubs and Spillovers

Abstract

Using a number of advanced statistical methods, this paper analyses the convergence and spillover effects of house price across UK regions. In contrast to the single steady-state often assumed in modern macroeconomic analyses, we find that house prices across UK regions can be grouped into four clusters, confirming the heterogeneity and complexity of the UK housing market. Moreover we document the dynamics of house price spillovers across regions.

Keywords: Regional house prices; Heterogeneity; Convergence; Spillovers.
JEL classification: E31, E52.

1 Introduction

The role played by the housing market in the latest financial crash and the following Great Recession, has led macroeconomic theory to investigate the contribution of housing wealth to the business cycle. This is frequently discussed by incorporating into a DSGE framework the household sector[1], whose consumption depends upon income and housing wealth.[2] The ultimate aim of the literature is to understand whether housing has an impact on economic fluctuations (see e.g. Iacoviello and Neri (2010)) in order to improve the forecastability of the business cycle and to formulate appropriate policy responses. The model solution is provided by nonlinear equations, which are then linearised (or *log*-linearised) so as to obtain fluctuations around the steady state as well as decision rules. This is similar to the assumption that the economy is subject to only small disturbances and, importantly, the resulting equilibrium is unique. Since the steady state is defined under certain modelling conditions, it is important to evaluate whether this prediction and uniqueness are supported by the data.

We contribute to the literature by testing whether the UK housing market is characterized by a single long run equilibrium, which all economic regions converge to. Although the UK housing market has been subject to extensive research, there is no clear agreement on whether a long-run convergence path exists. Early studies (e.g. MacDonald and Taylor (1993)) fail to find a robust convergence path; more recently Cook (2006) suggests that the previous negative evidence might be caused by asymmetric adjustment across regions. Holmes and Grimes (2008) find favourable evidence but suggest that moving towards a long-run equilibrium could be slow and takes quite a long time.

To this end, the novelty of this paper consists of the implementation of a log t test (Phillips and Sul (2007b)) to test whether multiple equilibria (i.e. convergence clubs) are present.[3] This approach has attractive features regarding the treatment of the steady state (or the common factor); among others, we can not only estimate the number of steady states among regional markets endogenously by the data, but can also analyze the compositions of convergence clubs. Furthermore, we complement our analysis by looking

[1]The DSGE stands for the dynamic stochastic general equilibrium.

[2]See Iacoviello (2010, 2011) for a review and the influential model presented in Iacoviello and Neri (2010).

[3]This method has been implemented in economic growth literature (e.g., Phillips and Sul (2007a, 2009) as well as in convergence in prices Phillips and Sul (2007b)).

at house price spillovers across regions, and analyse the differences in the dynamics that drive return (i.e. inflation) and volatility spillovers over time for UK regions. The variance decomposition analysis based on the vector autoregression (VAR) model allows us to identify spillovers due to return and volatility shocks.

In a nutshell, our results suggest the presence of multiple steady states (convergence clubs) in the UK housing market. While London's housing market is very influential over other regions' (i.e., the ripple effect), inter-regional effects are also observed within convergence clubs, yielding regional diversity in the UK housing market. This departs from a single steady state often assumed by macroeconomic models.

2 Literature survey

Numerous studies have investigated the dynamics of national and regional house prices. We can identify two strands in the literature. The first is concerned with house price valuation; here, the main objective is to understand the link between economic fundamentals and property valuation, both at a national and at a regional level (see e.g. Cameron et al. (2006)). The aim is to try to identify which macroeconomic factors can help policymakers to detect possible deviation from fundamentals and the formation of bubbles. As Muellbauer and Murphy (2008, p. 5) explain, "the deviation of prices from long-run fundamentals is then the bubble-burster." More specifically, house prices may surge due to a series of positive shocks to fundamentals such as households earnings. Thus, the expectation of further appreciation leads to overvaluation, but in due course the realisation that improvement in fundamentals has been outpaced by house price increases, leads to a slowdown in the rate of appreciation.[4] McMillan and Speight (2010) analyse deviations of house prices from fundamental values in terms of the present value model of the asset price literature. Here the price of an asset is explained by the fundamental, which is the expected future payoffs of the asset itself; in the stock market literature these payoffs are dividends, while for bonds they are represented by interest and principal payments. The theoretical underpinning for the hypothesis that current price earnings ratios predict

[4] There is a relatively vast literature examining the boom in house prices; mainly covering countries which experienced a major boom during the nineties. See e.g., Cameron et al. (2006) and Black et al. (2006) in the UK, Abelson et al. (2005) in Australia; and Stevenson (2008) in Ireland. A cross-country comparison is provided by Girouard et al. (2006)

future movements in stock prices. In applying this methodology to the housing market the authors utilize the price-to-income ratio to investigate possible irrational deviations from fundamentals, nevertheless we should expect the current price-to-rent ratio, rather than price-to-income, to fit the theoretical model and predict future movements in house prices. In fact it is the rent rather than the personal income which represents the stream of future payoffs for the owner of the dwelling.

The second strand in the literature investigates the dynamics developing in regional property prices and the possible existence of a 'ripple effect'. If regions were geographically close entities then standard economy theory would suggest that the level of house prices within a certain area would be determined by the local demand and supply. Hence house prices across regions would be on different levels and would move independently although they would be still determined by similar economic factors (e.g. demographic factors and economic conditions). This idea was first challenged by Meen (1999) who introduced the possibility of a 'ripple effect' in the housing market. This refers to the fact that changes in the housing market are first observed in one region (usually the core region), and then they are transmitted to the adjacent regions, followed by propagation to other, more peripheral, regions. He suggested that this effect is driven by four different factors: migration, equity transfer, spatial arbitrage and spatial patterns.

Starting from the seminal paper by Meen (1999) the literature has proposed testing this hypothesis using various econometric techniques. The first approach has been to use cointegration analysis to investigate the notion of a causal long-run link between different regional house prices, in this spirit the works of, among others, MacDonald and Taylor (1993) and Alexander and Barrow (1994).[5] Results for the UK economy are not conclusive, while MacDonald and Taylor (1993) and Alexander and Barrow (1994) find that a long-run relationship exists, Ashworth and Parker (1997) cast doubts on these results. A second econometric approach to test the 'ripple effect' is by a using unit root test. As Cook (2005) explains, the diffusion of changes in house prices that the 'ripple effect' implies, is consistent with a constant long-run ratio of regional to aggregate house prices. He finds that the aforementioned ratio is stationary for a number of UK regions

[5] Chen et al. (2011) use a similar methodology for Taiwan, while Gupta and Miller (2012) investigate the US market.

thereby supporting the notion of a 'ripple effect'.[6] More recently, Holmes and Grimes (2008) find that the first principal component of the differentials between regional and national houses prices is stationary, implying that UK regional house prices are driven by a single common stochastic trend.

We follow more closely the second strand of the literature. In particular, we test for multiple equilibria (i.e. convergence clubs) in the various housing markets across the UK and then investigate spillovers across the UK.

3 Econometric framework

This paper uses mainly two statistical approaches in order to analyze regional inflation. First, we use the log t test to examine if there is convergence in regional inflation. There are other approaches for convergence analysis, such as the principle components approach (e.g., Homes and Grimes (2008)) and the panel unit root tests (e.g., Levin et al. (2002); Im et al. (2003)). But these methods are not as suitable as the log t test to analyze convergence clubs because it is difficult to identify the composition of regions in convergence clubs by the former approach, while the latter does not address convergence clubs at all since the unit root tests are a statistical method to detect a conditional convergence, in which the steady state can differ among all regions. The log t test deals with these two issues.

Second, data will be decomposed using the quantitative method (Diebold and Yilmaz (2009)), in order to study spillover effects from one region to others, a method which was originally developed to study spillovers in financial asset prices and has never been applied to inflation analysis.

3.1 The log t test

For the analysis of convergence, we shall use the Phillips-Sul method (Phillips and Sul (2007b)); assume that panel data X_{it} with time $(t = 1, ..., T)$ and country $(i = 1, ..., N)$ is decomposed to the permanent (a_{it}) and transitory (g_{it}) components.

[6] A similar conclusion, using a two-stage procedure is reached by Cook and Thomas (2003). This is one of few studies to consider volatility rankings rather than just price rankings.

$$X_{it} = a_{it} + g_{it} \quad (1)$$

Since both components (a_{it} and g_{it}) may contain a common factor across regions (μ_t), equation (1) can be re-expressed as:

$$X_{it} = \left[\frac{(a_{it} + g_{it})}{\mu_t} \right] \mu_t = \delta_{it}\mu_t \quad (2)$$

Having recovered the time-varying idiosyncratic factor δ_{it}, the common factor will be calculated as cross-sectional average of the panels under investigation. Since Eq. (2) suggests the presence of convergence of X_{it} if δ_{it} exhibits such evidence, the behaviour of the common factor is not the main focus in our definition of convergence. In other words, although this approach restricts to a single steady state case in a panel (X_{it}), the stationarity of the steady state will not affect our analysis of convergence.

Furthermore, the idiosyncratic component (δ_{it}) is assumed to follow the following specification which is discussed as suitable for economic data (Phillips and Sul (2007b)).

$$\delta_{it} = \delta_i + \sigma_i \xi_{it} L(t)^{-1} t^{-\alpha} \quad (3)$$

Following Phillips and Sul (2007a,b), $L(t)$ has a form of $\log t$, and $\xi_{it} \sim IID(0,1)$. Since δ_i and σ_i are region-specific fixed terms and given that $\log t$ is an increasing function over time, whether or not X_{it} converges toward δ_i will be determined by the size of α. They show that the convergence is ensured if $\alpha \geq 0$, and this null hypothesis can be tested using Eq. (4).

$$log(H_1/H_t) - 2log(L(t)) = a + blog(t) + u_t \quad (4)$$

where $L(t) = log(t+1)$, $H_t = (1/N)\sum_{i=0}^{N}(h_{it} - 1)^2$ and $h_{it} = X_{it}/N^{-1}\sum_{i=1}^{N} X_{it}$. Eq. (4) suggests that, all other things being equal, a large $log(H_1/H_t)$ corresponds to a large b. This in turn follows that $H_t \to 0$ as $t \to \infty$, which suggests that $h_{it} \to 1$ as $t \to \infty$. The latter implies that X_{it} approaches the cross-sectional average and thus is evidence of convergence. Alternatively, a negative b becomes evidence of non-convergence. Thus, the convergence hypothesis is tested by the null hypothesis of $b = 0$ against the alternative of non-convergence $b < 0$.

Since a rejection of the null does not necessarily imply that there is no convergence among regions which did not form an initial convergence club. The strategy is to search for convergence across all combinations of regions until $N - k = 1$, where k is the number of regions in convergence clubs. This terminal condition is the case where there is no further subgroup since multiple regions are required for the study of convergence.

3.2 Spillovers

The spillovers across regions are analysed using the Diebold and Yilmaz (2009) framework. For brevity of exposition consider a covariance stationary bivariate VAR $y_t = A_1 y_{t-1} + e_t$ or alternatively $y_t = \Theta(L)e_t$ in a moving average form. This can be re-written as $y_t = B(L)u_t$ where $B(L) = \Theta(L)Q_t^{-1}$, $u_t = Q_t e_t$, $E(u_t, u_t') = I$ and Q_t^{-1} is the lower-triangle Cholesky factor of the covariance matrix of e_t. The one-step ahead forecast ($y_{t+1,t} = Ay_t$) has an error vector given by:

$$\widehat{e_{t+1,t}} = y_{t+1} - y_{t+1,t} = B_0 u_{t+1} \begin{bmatrix} b_{0,11} & b_{0,12} \\ b_{0,21} & b_{0,22} \end{bmatrix} \begin{bmatrix} u_{1,t+1} \\ u_{2,t+1} \end{bmatrix} \tag{5}$$

The variance of the one-step ahead error in forecasting y_{1t} is $b_{0,11}^2 + b_{0,12}^2$ and $b_{0,21}^2 + b_{0,22}^2$ is that in forecasting y_{2t}. Moreover, following Diebold and Yilmaz (2009) the off-diagonal elements are the cross-market spillovers. The spillover index is then defined as:

$$S = \frac{b_{0,12}^2 + b_{0,21}^2}{b_{0,11}^2 + b_{0,12}^2 + b_{0,21}^2 + b_{0,22}^2} 100 \tag{6}$$

The model can easily be extended to the case of $N = 12$ and 4-step ahead forecasts as in our case, and our analysis is based on VAR(1) which is determined by the Schwarz information criterion. Furthermore, in order to obtain results robust to the order of variables in the VAR, we implement a decomposition method, the generalized impulse response function, which was developed by Koop et al. (1996) in the context of the multivariate nonlinear model.

4 Data

Quarterly data on house prices for the twelve UK regions are obtained from Lloyds Banking Group. These data are classified by region; the North, York & Humberside, North West, East Midlands, West Midlands, East Anglia, South West, South East, Greater London (hereafter London), Wales, Scotland and Northern Ireland. The price data are standardized and seasonally adjusted, and cover the period from 1983Q1 to 2012Q3. This data set has been previously employed by a number of researchers (e.g. Gregoriou et al. (2014)).

Table 1 provides a snapshot of our data set. House prices are, on average, higher in London compared to anywhere else in the UK, for instance in Scotland, about half of London's price. The second part of Table 1 shows house price inflation. The inflation is defined as the annual growth rate of house prices, i.e., $log(p_t) - log(p_{t-4})$.[7] Here we do not notice any major difference across regions; prices in London and adjacent regions tend to grow faster but not by a large margin. Also the standard deviation does not indicate any significant difference.

In Table 2 we provide some further evidence of the relationship among regional house prices. Indeed, while a causality issue is not touched upon, it shows indirect evidence of our main hypothesis of the existence of a ripple effect. In particular, both house prices and inflation in London appear to be highly correlated with those in geographical proximity to the region.

Furthermore, we complete our preliminary data analysis with three tests for cross sectional dependence (Free, Pesaran, and Friedman tests). The results presented in Table 3 show that we can strongly reject the null hypothesis of no cross-sectional dependence, implying the existence of significant spillovers in the housing market.

Overall, our preliminary analyses suggest that regional housing markets are highly integrated to one other as their prices and inflation move in tandem with each other. However, in the next section, more vigorous analyses will unveil some heterogeneity across regions.

[7] We prefer to use annual inflation rather than quarterly inflation since the housing market is a slow moving market and quarterly variations may not capture the dynamics we are interested in this paper.

5 Empirical results

5.1 Multiple convergence clubs in the UK housing market

In order to apply the log t test to house prices, a matrix is created with the order of regions based on their average house prices in the final year (i.e., 2012). Then house price convergence will be tested by creating a subgroup which contains first the two most expensive regions and then adding, one by one, less expensive regions to the subgroup. Thus, Greater London (hereafter London), the most expensive region, becomes one of the core member regions.

The results of the test are reported in Table 4, where we also report the estimated *t-statistics*. Initially, this table shows whether London and South East (the second most expensive region in the UK) form a convergence club, and a *t-statistic* of -48.16 suggests that we can reject the convergence hypothesis. This confirms that house prices in London are substantially different from the rest of the UK. Next, we test whether regions other than London form a convergence club. Again no evidence of convergence is obtained with a *t-statistic* of -49.23.

The next task is to check if there are any regions which exhibit convergence with the South East. After examining all combinations of house prices in regions other than London, we find evidence of convergence in the subgroup consisting of the South East, South West, East Anglia and Northern Ireland. Their *t-statistic* is positive although it is insignificant. Then, as before, convergence is checked among regions which have not become a member of any convergence groups (i.e., ones excluding London, South East, South West, East Anglia and Northern Ireland), and we find evidence of non-convergence (*t-statistic*=-26.39).

In the next round, we examine if the West Midlands, the most expensive region among the remainder, converges with some other regions. After considering all possibilities, we find evidence of convergence among the West Midlands, Wales and East Midlands. The *t-statistic* is negative but statistically insignificant, and thus the null of convergence cannot be rejected by the data. Furthermore, the remaining regions (the North West, York & Humberside, Scotland, and the North) are reported to form one convergence club.

Summing up, we find that the UK house market is subdivided into 4 convergence clubs named Groups A to D in Table 5. Group A consists of London alone, Group B of the South East, South West, East Anglia and Northern Ireland, Group C of the West Midlands, Wales and East Midlands, and Group D of North West, York & Humberside, Scotland, and the North. Interestingly the clubs seem to be spatially distributed with one notable exception (Northern Ireland, which is not adjacent to the South East, South West, and East Anglia). We can speculate that this anomaly is likely due to the strong price increases in Northern Ireland in the first half of the 2000s which matches other regions in Group B. In short, our results show evidence of heterogeneity in regional housing markets in the UK, and it is known that regional heterogeneity in the UK housing market can be explained by several economic factors such as migration, equity transfer, and spatial factors (e.g., Meen (1999)).[8]

The presence of four convergence clubs seems to complement the previous studies which have not found clear evidence of convergence under the assumption of a single steady state. Our findings suggest that such a presumption itself is not supported by the data, and they emphasize deciding an appropriate number and composition of each convergence club prior to detailed convergence analyses; otherwise, the results would become less credible.

5.2 Spillover effects

Panels A and B in Table 6 present the spillover effects across regions for annual house price inflation and inflation volatility (squared inflation), respectively. The ij cell is the estimated contribution to the forecast error variance of region i coming from innovations to region j. Hence summing the off-diagonal terms in each row of the matrix we obtain Contributions from Others, while Contributions to Others are obtained by adding up the terms in the columns. So, for instance, innovation in London housing market returns are responsible for 18.2 percent of the error variance in forecasting South East returns, but only 5.9 percent of the error variance in forecasting Scottish returns. From Table 6 we have two major effects; firstly, as expected, there is a higher spillover across adjacent regions. Second, the Spillover Index is obtained by dividing the sum of the Contributions from

[8]We did not carry out further analyses on regional heterogeneity since it is well documented in previous studies (Meen (1999)) and our focus is on spillover effects particularly from London to the rest of the UK.

Others by the Contributions to Others including Own. This indicates that 79.6% and 73.2% of the forecast error variance of annual inflation and volatility, respectively, can be explained by spillovers. However, this spillover effect is quantitatively more pronounced for the peripheral regions than for the core regions, while price innovations in other regions have limited impact on London and southern England. The result corroborates and supports the idea of a ripple effect from London prices to other regions. Interestingly, it should also be noted that the ripple effect from London seems to become weaker as regions are located further away from London.

Furthermore, from this table we find that the level of self-generating inflation becomes proportionally less important as one is distant from London, i.e., from Group A to Group D. For return (inflation) spillovers, the importance of self-generating inflation in London and Group B is about 26 and 30 percent respectively, and drops to around 14 percent in Groups C and D. This proportion is high in Group B due to Northern Ireland.[9] If we remove the effects of Northern Ireland, London is the region with the highest ratio of self-generating inflation. This general trend remains the same for volatility spillovers and demonstrates the dominance of London over the rest of the UK.

In addition, consistent with our preliminary analyses (Section 4), we can observe the notable size of spillovers within convergence clubs. Indeed, about 29 to 72 percent of return spillovers are generated in their own and neighboring regions in the same convergence clubs. This excludes a case of London, and is calculated for example as $30.8 = 16.0 + 7.3 + 7.5$ for the West Midlands. This seems to be one explanation for similarities in neighboring regional inflation.

This ripple effect can also be visually presented using the impulse response functions (IRFs). Here IRFs are again calculated by the approach proposed by Koop et al. (1996) with a shock given to equations for price changes (Figure 1) and volatility (Figure 2) for London or Northern Ireland for presentation purposes. The responses of other regions to the shock are averaged out among the same club members identified in our previous analysis. One exception is Northern Ireland which is not included in Group B in order to differentiate regions where a shock is produced or received.

These figures show a very sharp contrast depending upon whether the shock is given

[9] If Northern Ireland is removed from Group B, the proportion of self-generating inflation drops to 20 percent for this group.

to London or Northern Ireland. When a positive shock is given to house price inflation (volatility) in London, other regions follow suit. However, a shock occurring in Northern Ireland barely affects house price inflation (volatility) in other regions. Therefore, these figures also give rise to evidence of the ripple effect from London to other regions in the UK, but not vice versa. Note that while the results of shocks to other regions are not presented here, responses from such analyses are mixed and less clear than those presented in Figures 1 and 2.

6 Conclusions

This paper looks at the convergence and spillover effects in the housing market across twelve UK regions. We find the market to be characterized by four convergence clubs, far more complicated characteristics in the housing market than what the conventional macroeconomic model would suggest, and this is the first paper to quantify the number of steady states in the UK housing market. Thus it seems vital for macroeconomists to consider multiple equilibria in their analyses.

Moreover our results suggest the presence of a high degree of spillover across regions, with stronger spillover effects from the core regions. At the same time, we provide evidence of regional heterogeneity in the UK from the perspective of the housing markets, and suggest that policymakers monitor regional economic and financial developments although it does make sense to monitor closely London's prices which are more likely to have useful information to predict future housing prices in the rest of the UK through the ripple effect. After all, even a relatively small country like the UK consists of unique regional areas.

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Table 1: Basic Statistics of Regional House Prices

Price level	Average	Std Dev	Max	Min	obs
Gr.Lon	149671	85566	322769	38523	119
South East	133234	69981	265318	39265	119
South West	106973	58726	212995	32307	119
East Anglia	96951	51286	195604	28915	119
W.Mids	91923	48732	184958	27817	119
E.Mids	83526	44904	169528	25247	119
Wales	78924	44239	167810	25354	119
North	73324	41094	156202	24538	119
North West	75808	39886	154492	24968	119
Yorks&Humb	72021	38892	149716	22512	119
Scotland	72324	33652	145242	27808	119
N.Ireland	75820	51753	229590	24947	119
Inflation					
Gr.Lon	0.066	0.108	-0.239	0.256	115
South East	0.060	0.105	-0.222	0.304	115
South West	0.059	0.112	-0.181	0.419	115
East Anglia	0.059	0.120	-0.253	0.433	115
W.Mids	0.058	0.108	-0.173	0.473	115
E.Mids	0.058	0.111	-0.212	0.431	115
Wales	0.057	0.110	-0.214	0.383	115
North	0.055	0.103	-0.207	0.327	115
North West	0.054	0.099	-0.207	0.308	115
Yorks&Humb	0.057	0.107	-0.190	0.410	115
Scotland	0.047	0.075	-0.166	0.217	115
N.Ireland	0.050	0.129	-0.354	0.428	115

Notes: The regions are listed following the order of prices (high to low) of the average price in the final year (i.e., 2012). Full sample period 1983Q1-2012Q3. Inflation rates are annual $(log(p_t) - log(p_{t-4}))$.

Table 2: Correlation prices

	Gr.Lon	S.E	S.W	E.Ang	W.M	E.M	Wales	North	NW	Yorks	Scot	N.Ire
Prices												
Gr.Lon	1											
S.East	0.998	1										
S.West	0.993	0.997	1									
E.Ang	0.99	0.996	0.997	1								
W.Mids	0.97	0.979	0.987	0.982	1							
E.Mids	0.977	0.985	0.993	0.989	0.997	1						
Wales	0.965	0.972	0.982	0.978	0.995	0.995	1					
North	0.945	0.953	0.965	0.958	0.986	0.985	0.995	1				
N.West	0.949	0.957	0.969	0.962	0.992	0.989	0.996	0.997	1			
Yorks&Humb	0.947	0.956	0.969	0.963	0.992	0.99	0.996	0.996	0.999	1		
Scot	0.936	0.941	0.95	0.944	0.975	0.97	0.983	0.989	0.988	0.988	1	
N.Ire	0.943	0.939	0.939	0.929	0.936	0.938	0.948	0.948	0.94	0.936	0.959	1
Inflation												
Gr.Lon	1											
S.East	0.949	1										
S.West	0.853	0.944	1									
E.Ang	0.865	0.937	0.94	1								
W.Mids	0.671	0.792	0.898	0.829	1							
E.Mids	0.717	0.825	0.904	0.824	0.951	1						
Wales	0.584	0.66	0.747	0.677	0.895	0.885	1					
North	0.349	0.395	0.48	0.383	0.702	0.714	0.86	1				
N.West	0.452	0.504	0.589	0.498	0.788	0.792	0.902	0.932	1			
Yorks&Humb	0.474	0.556	0.668	0.559	0.858	0.863	0.934	0.92	0.948	1		
Scot	0.349	0.361	0.394	0.361	0.584	0.574	0.737	0.804	0.818	0.786	1	
N.Ire	0.348	0.326	0.314	0.293	0.307	0.299	0.383	0.364	0.396	0.383	0.574	1

Table 3: Cross-sectional Independence of Regional House Prices

Test type	Price level	Inflation
Frees	10.878 (0.000)	5.871 (0.000)
Pesaran	86.132 (0.000)	57.052 (0.000)
Friedman	1359.172 (0.000)	950.603 (0.000)

Notes: The figures in parentheses are p-values.

Table 4: The Convergence test for UK regional house price

Test	Group	1) t-statistic	Rest of Group	2) t-statistic
Test A	Gr. London South East	-48.16	All others excl. Gr. London	-49.23
Test B	South East South West East Anglia N. Ireland	1.16	All others excl. Gr. London South East, South West East Anglia, N. Ireland	-26.39
Test C	W. Mids Wales E. Mids	-1.25	North West, Yorkshire & H. Scotland, North	3.56

Notes: The test is based on Phillips and Sul (2007b)

Table 5: The Convergence club

Clusters	Regions	Average price
Group A	Gr. London	149671
Group B	South East, South West, East Anglia, N. Ireland	103245
Group C	W. Mids, Wales, E. Mids	84791
Group D	North West, Yorkshire & H., Scotland, North	73369

Notes: In *GBP*.

Table 6: Spillover effects across regions

	Gr. London	South-East	South-West	East Anglia	W. Mids	E. Mids	Wales	The North	North West	York.&H.	Scotland	N.Ireland	From others
Panel A - annual regional inflation													
Gr. London	25.9	15.0	10.0	9.4	3.7	6.2	7.2	7.3	3.9	7.2	1.4	2.9	74.0
South East	18.2	18.1	13.5	11.7	5.8	6.5	6.3	6.9	3.7	5.6	1.7	2.0	82.0
South West	12.2	13.6	17.1	14.1	9.4	7.0	7.3	5.8	4.7	5.9	1.8	1.1	83.0
East Anglia	13.7	16.1	12.0	22.3	7.3	3.8	6.1	6.1	4.4	4.1	2.8	1.3	78.0
W. Mids	8.0	9.7	14.3	13.2	16.0	7.3	7.5	5.5	7.3	7.8	2.8	0.6	84.0
E. Mids	10.4	10.6	13.4	12.6	9.9	11.5	7.4	6.7	6.5	8.0	2.4	0.4	88.0
Wales	8.2	8.4	11.3	10.6	12.0	6.9	15.1	8.0	6.4	9.3	2.6	1.1	85.0
North	8.1	6.3	8.5	7.0	10.0	8.1	12.2	16.5	7.3	12.0	3.4	0.6	84.0
North West	7.4	6.7	11.4	7.2	10.3	8.3	10.7	8.8	13.4	12.7	1.8	1.2	87.0
York.&H.	7.4	7.5	12.2	9.1	12.2	8.8	10.0	7.7	7.3	13.8	3.2	0.7	86.0
Scotland	5.9	7.5	8.5	6.0	8.1	6.0	6.5	10.8	5.8	11.8	14.8	8.2	85.0
N.Ireland	4.0	2.6	5.6	2.8	3.3	2.1	0.7	10.2	1.3	3.6	3.1	60.7	39.0
To others	104.0	104.0	121.0	104.0	92.0	71.0	82.0	84.0	59.0	88.0	27.0	20.0	955.0
													Spillover index
Including own	130.0	122.0	138.0	126.0	108.0	83.0	97.0	100.0	72.0	102.0	42.0	81.0	**79.60**
Panel B - regional inflation volatility													
Gr. London	47.7	20.0	8.6	7.3	2.3	3.3	1.4	0.1	1.9	2.1	1.4	4.0	52.0
South East	25.6	27.7	14.7	17.1	3.0	3.3	1.1	0.7	1.4	0.3	3.1	2.1	72.0
South West	10.9	17.3	20.9	29.1	7.3	4.0	3.4	0.9	2.1	1.0	2.8	0.4	79.0
East Anglia	14.0	22.9	15.1	34.5	4.1	0.8	2.1	0.3	0.6	0.2	4.1	1.3	66.0
W. Mids	5.9	13.8	19.7	28.8	12.1	4.6	5.9	2.1	2.7	2.1	1.8	0.5	88.0
E. Mids	5.9	11.8	19.8	23.0	7.2	15.3	4.8	1.8	5.8	2.9	1.3	0.4	85.0
Wales	3.4	7.1	13.7	13.5	13.5	6.1	18.0	12.0	4.9	5.0	1.1	1.6	82.0
North	1.1	2.2	7.4	2.9	7.4	11.9	16.8	33.4	3.8	11.1	1.3	0.7	67.0
North West	3.0	5.4	12.3	7.9	9.3	10.5	16.0	11.2	12.9	9.8	0.2	1.5	87.0
York.&H.	2.9	6.9	17.1	16.4	12.9	8.7	11.4	8.5	5.1	8.2	0.4	1.5	92.0
Scotland	1.0	2.6	6.0	1.7	5.9	3.8	11.3	13.5	4.9	11.5	19.3	18.5	81.0
N. Ireland	1.9	2.3	1.4	0.2	0.9	0.3	3.1	4.0	1.4	6.6	6.3	71.6	28.0
To others	75.0	112.0	136.0	148.0	74.0	57.0	77.0	55.0	35.0	53.0	24.0	33.0	878.0
													Spillover index
Including own	123.0	140.0	157.0	182.0	86.0	73.0	95.0	89.0	48.0	61.0	43.0	104.0	**73.20**

Notes: Variance decomposition based on Diebold and Yilmaz (2009).

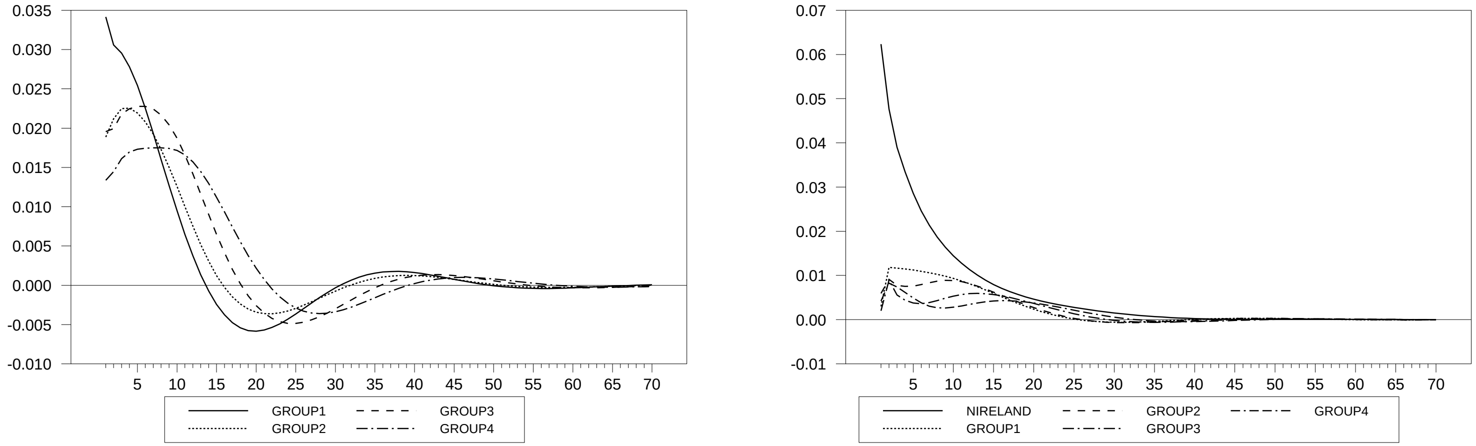

Figure 1: IRF for house price inflation: a shock given to London (left) and N Ireland (right)

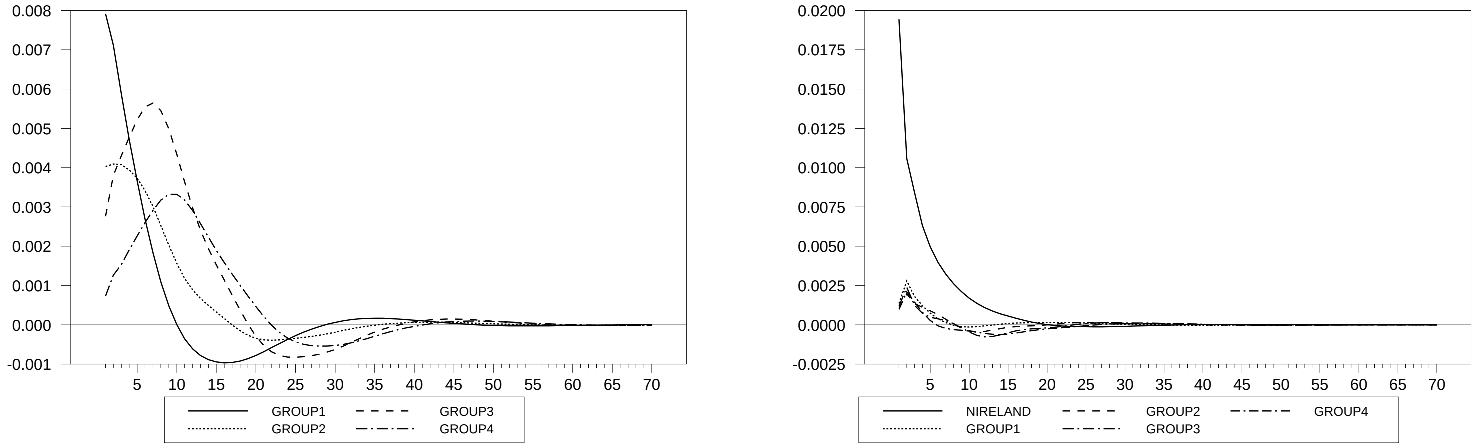

Figure 2: IRF for price volatility: a shock given to London (left) and N Ireland (right)