Spillovers, Contagion, and Interconnectedness of Local Housing Markets across the UK

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Introduction

UK house prices have trended upwards in real terms over time while experiencing periods of significant volatility. This is also true of regions.

Previous studies have tended to examine regional interlinkages, for example in the form of a ripple hypothesis (Meen, 1990, 1999) or, more recently, by using measures of connectedness between regions (Antonakakis et al., 2018)

We employ data at local authority level for UK cities and surrounding areas to examine connectedness and price spillovers between cities and their neighbouring municipalities

There are reasons for believing that commonalities exist in the returns across housing submarkets; these can be due to national economic growth trends, nominal interest rates, mortgage markets, fiscal policy. These macroeconomic factors should influence all regions in the same manner, given that the factors do not vary much across regions (Meen 1999).

Meen (1999) proposed four possible explanations for the interactions that lead to the observed pattern of spillover terms and the ripple effect. These explanations were migration, equity transfer, spatial arbitrage and spatial patterns in the determinants of housing prices.

However, Holmans (1990) argued that migration flows are not quantitatively large enough to cause the observed movements of housing prices, the monthly changes in housing prices were more likely to have resulted from financial flow and information transmission without households physically moving.

Attanasio *et al.*, (2009) note that there may be some form of common causality that links regions therefore leading to significant correlations.

Literature

Literature

Antonakakis et al. (2018) examine the connectedness of the UK regional housing returns using a dynamic measure of connectedness developed by Diebold and Yilmaz (2014).

Overall, their findings indicate that the transmission of inter-regional property returns shocks is an important source of regional property return fluctuations.

What is more, this is a dynamic, event-dependent process which implies that, over time, any UK region can be both a net transmitter and a net receiver of shocks.

Literature

In commercial real estate, Liow and Schindler (2017) examine linkages between office markets in Europe using the generalised spillover index of Diebold and Yilmaz (2012)

They find time varying significant volatility spillovers across leading office markets.

London offices were a ‘volatility leader’ with significant spillovers to other European office markets

Their finding of volatility spillover cointegration implies the presence of unobserved common shocks that might undermine international investors’ diversification strategies

Approach

In this presentation we examine housing markets in selected UK cities and their contiguous local authority (municipality) areas.

The municipality data are from 1995q1 to 2019q2 for England, and from 2004q1 to 2019q2 for Scotland.

We use primary urban areas data for England and local authority areas for Scotland to define the municipalities to be included surrounding each city.

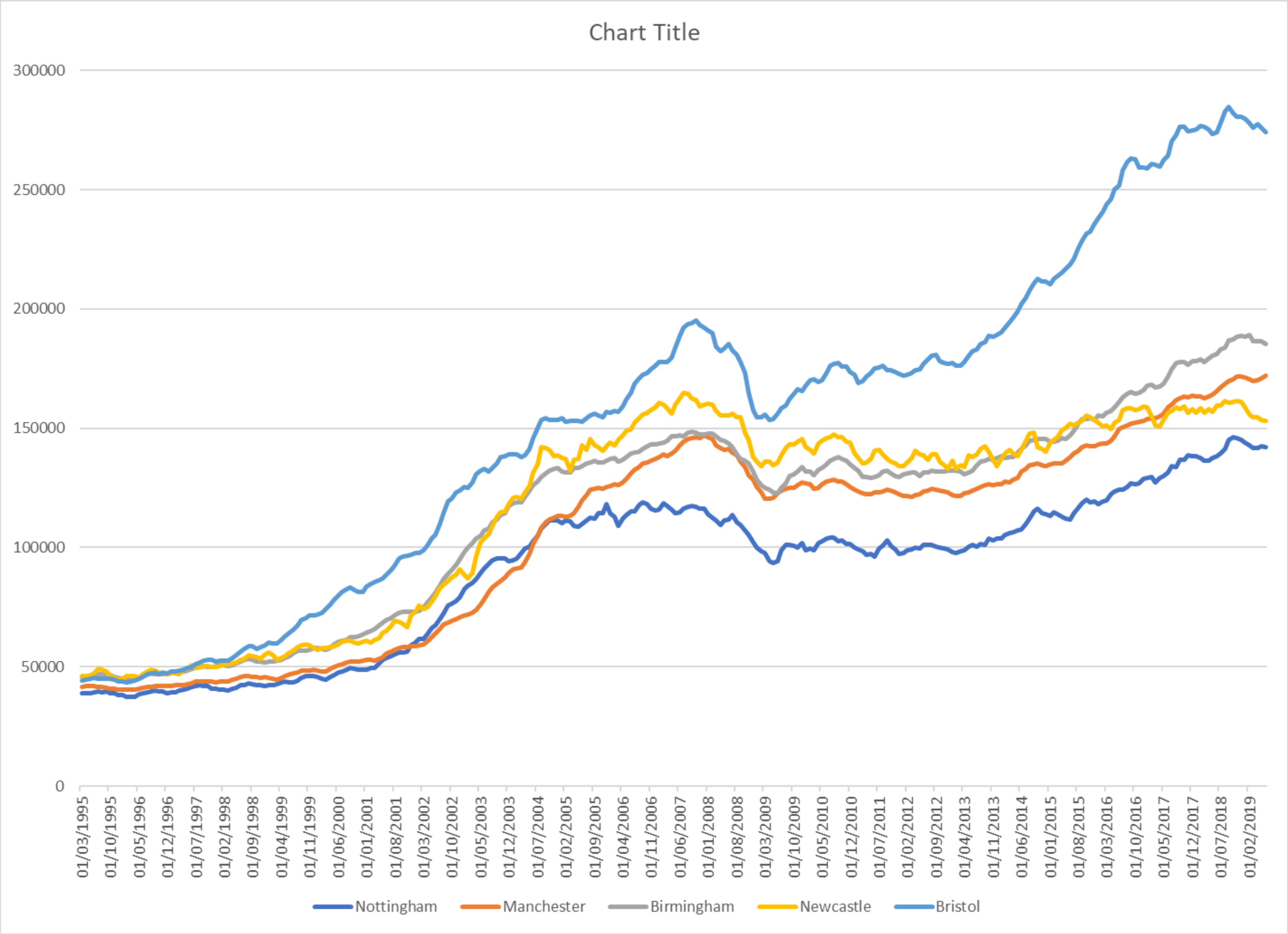
For the locations we cover, urban areas often spread contiguously over municipality boundaries

We adopt a generalised vector autoregressive approach to capture return spillovers.

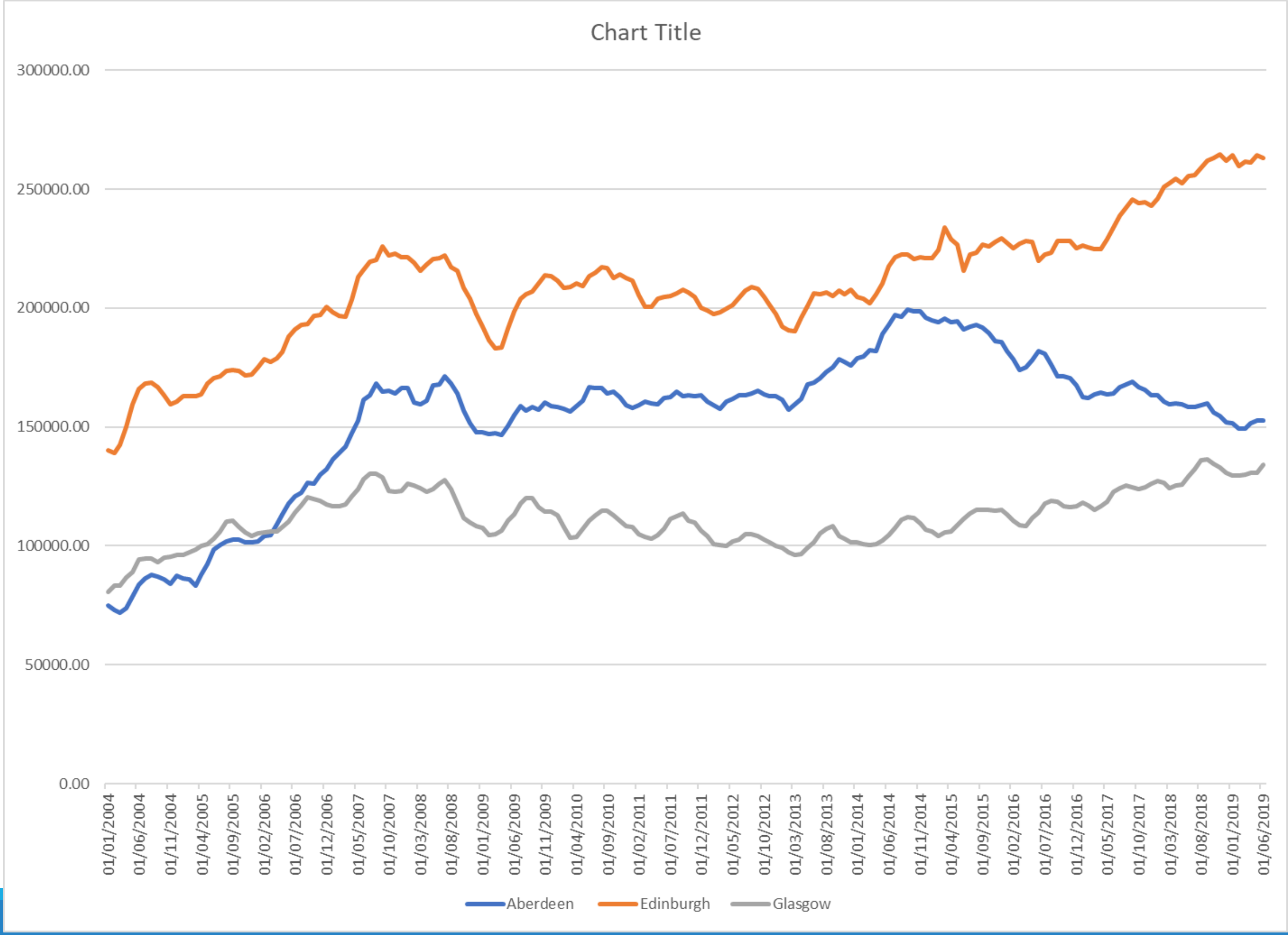
Following the research developed by Diebold and Yilmaz (2012, 2014) we employ variance decomposition analysis to find the share of each municipality's own variance to itself and to other contiguous local authorities.

Finally, we consider how our results compare with regional studies on house price return spillovers.

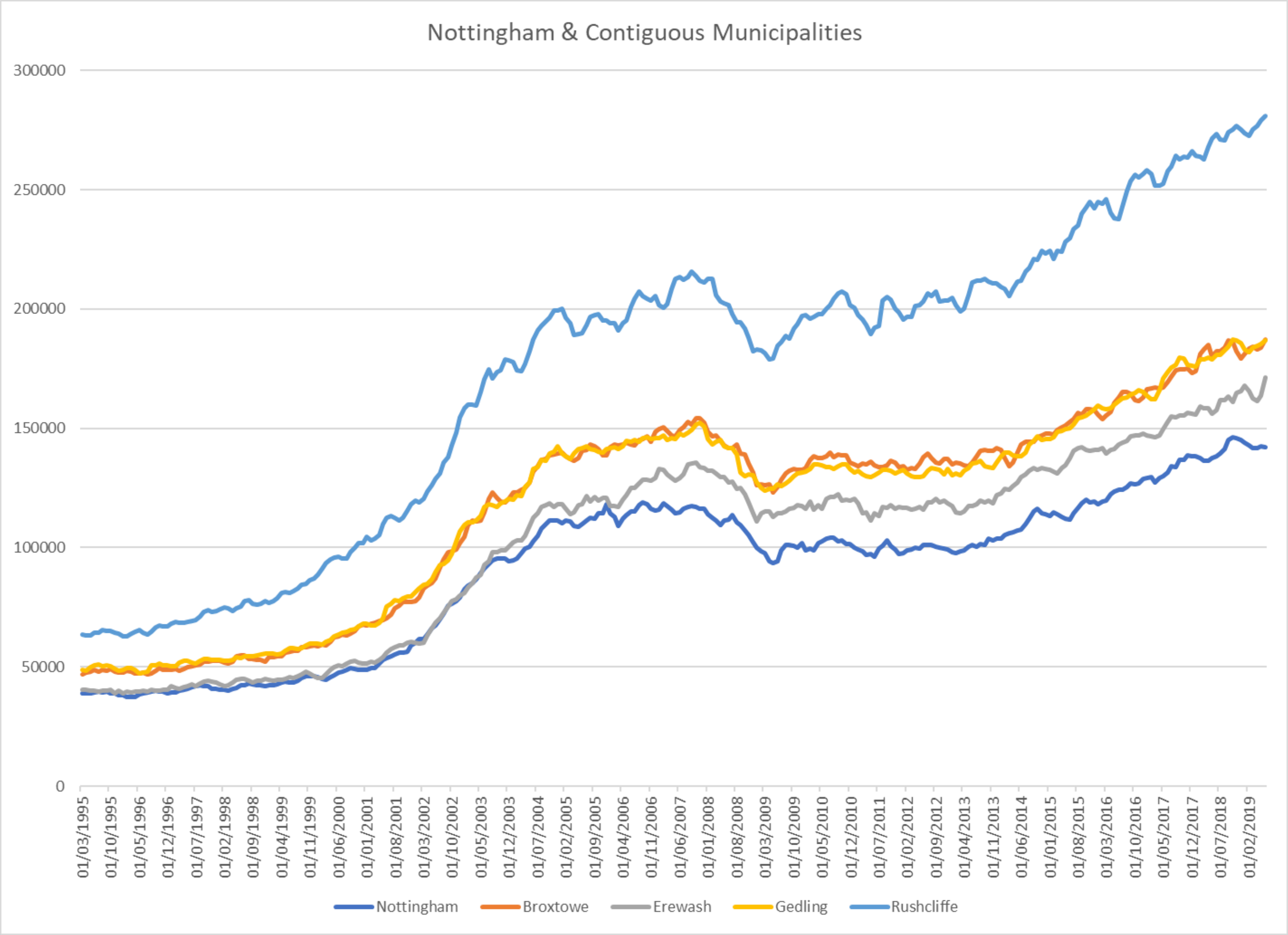
House Prices in England: Regional Cities



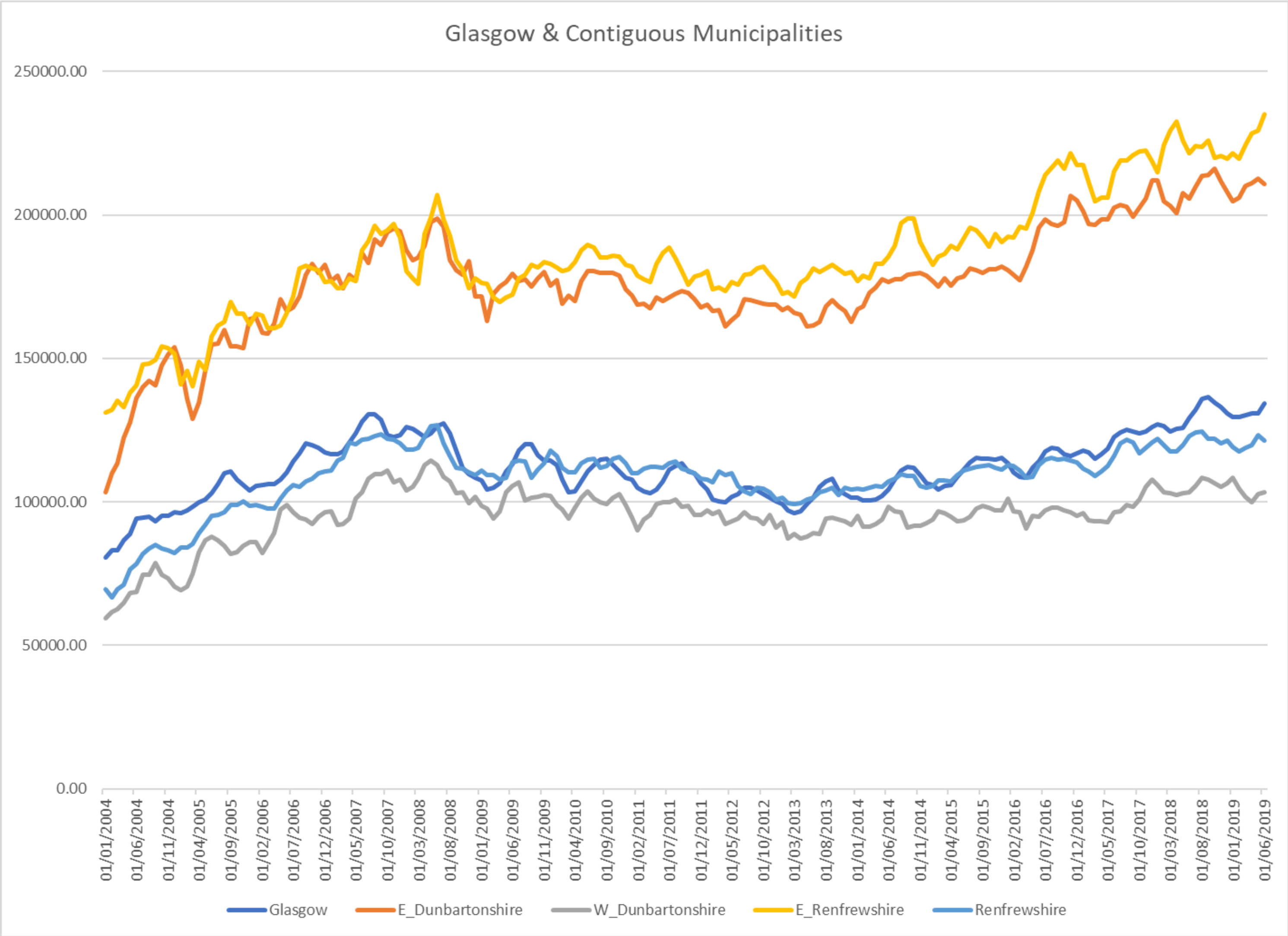
House Prices in Scottish Cities



Nottingham & Surrounding Areas



Glasgow & Surrounding Areas



Methodology

Consider a covariance stationary N-variable VAR(p) with independently and identically distributed disturbances that have a moving average representation.

From the MA terms we can split the forecast error variances of each variable related to system shocks.

The variance decompositions let us find the proportion of the forecast error variance in x_i due to shocks to x_j

H step ahead forecast error variance:

$$\varphi_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' A_h \sum e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \sum A_h' e_i\right)}$$

Where Σ is the variance matrix of the error vector, σ_{ij} is the standard deviation of the error term for j^{th} equation, A_h is an N × N coefficient matrix, and e_i is a selection vector with 1 as the i^{th} element, zero otherwise.

Spillover Indices: Total Connectedness

The own and cross-variable variance contribution shares do not aggregate to 1 under the generalised decomposition, hence each entry of the variance decomposition matrix is normalised by its row sum:

$$\tilde{\varphi}_{ij}(H) = \frac{\varphi_{ij}(H)}{\sum_{j=1}^{N} \varphi_{ij}(H)} \text{ with } \sum_{j=1}^{N} \tilde{\varphi}_{ij}(H) = 1, \text{ and } \sum_{j=1}^{N} \tilde{\varphi}_{ij}(H) = N$$

The total connectedness or spillover index measuring the contribution of connectedness from shocks from all other sectors to the total forecast error variance is:

$$TC(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\varphi}_{ij}(H)}{\sum_{j=1}^{N} \tilde{\varphi}_{ij}(H)} \times 100$$

$$= \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\varphi}_{ij}(H)}{N} \times 100$$

Spillover Indices: Directional Connectedness

Directional Connectedness received by region i from all other regions j is measured as:

$$DC_{i\leftarrow j}(H) = \frac{\sum_{i,j=1,j\neq i}^{N} \tilde{\varphi}_{ij}(H)}{\sum_{j=1}^{N} \tilde{\varphi}_{ij}(H)} \times 100$$

$$= \frac{\sum_{i,j=1,j\neq i}^{N} \tilde{\varphi}_{ij}(H)}{N} \times 100$$

Directional connectedness from regions i to all other regions j is:

$$DC_{i\rightarrow j}(H) = \frac{\sum_{j=1,j\neq i}^{N} \tilde{\varphi}_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\varphi}_{ji}(H)} \times 100$$

$$= \frac{\sum_{j=1,j\neq i}^{N} \tilde{\varphi}_{ji}(H)}{N} \times 100$$

Net connectedness can be found for each region by subtracting $DC_{i\leftarrow j}$ from $DC_{i\rightarrow j}$

Results: Introduction

All variables are I(1) and we run Granger Causality tests across the main cities

The return is calculated as the percentage change in price from t-1 to t, we do not have rental time series

There was no evidence of ARCH effects or bubbles (GSADF test) for any time series.

The spillover tables report direction of, and total connectedness

The ij^{th} entry is the estimated contribution to the forecast error variance of property municipality i coming from shocks (innovations) to property municipality j

Diagonal elements measure intra-municipality connectedness

The row sums excluding the main diagonal elements labelled ‘Connectedness from others’, report the total connectedness to (received by) the particular region in the respective row

The column sums labelled ‘Connectedness to others’ report the total connectedness from (transmitted by) the particular region in the respective column.

Granger-Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
BIRMINGHAM does not Granger Cause NOTTINGHAM	91	8.11423	1.E-05
NOTTINGHAM does not Granger Cause BIRMINGHAM		2.21701	0.0742
MANCHESTER does not Granger Cause NOTTINGHAM	91	8.55241	8.E-06
NOTTINGHAM does not Granger Cause MANCHESTER		1.95476	0.1092
BRISTOL does not Granger Cause NOTTINGHAM	91	6.39083	0.0002
NOTTINGHAM does not Granger Cause BRISTOL		0.65578	0.6245
NEWCASTLE does not Granger Cause NOTTINGHAM	91	4.16580	0.0040
NOTTINGHAM does not Granger Cause NEWCASTLE		3.86058	0.0063
MANCHESTER does not Granger Cause BIRMINGHAM	91	2.47426	0.0507
BIRMINGHAM does not Granger Cause MANCHESTER		3.61950	0.0091
BRISTOL does not Granger Cause BIRMINGHAM	91	0.79517	0.5317
BIRMINGHAM does not Granger Cause BRISTOL		3.26224	0.0156
NEWCASTLE does not Granger Cause BIRMINGHAM	91	1.82667	0.1315
BIRMINGHAM does not Granger Cause NEWCASTLE		5.02967	0.0011
BRISTOL does not Granger Cause MANCHESTER	91	1.61895	0.1773
MANCHESTER does not Granger Cause BRISTOL		4.39859	0.0028
NEWCASTLE does not Granger Cause MANCHESTER	91	3.11229	0.0195
MANCHESTER does not Granger Cause NEWCASTLE		7.48004	3.E-05
NEWCASTLE does not Granger Cause BRISTOL	91	1.48097	0.2155
BRISTOL does not Granger Cause NEWCASTLE		5.51917	0.0006

In summary, Manchester and Birmingham G-C most other cities

Nottingham does not G-C any city except Newcastle

Newcastle G-C Nottingham and Manchester while Bristol G-C Newcastle

House Price Return Spillovers Scottish Cities 2004-2019

Spillover (Connectedness) Table

	aberdeen	aberdeenshire	From Others
aberdeen	95.9	4.1	4.1
aberdeenshire	43.5	56.5	43.5
Contribution to others	43.5	4.1	47.6
Contribution including own	139.3	60.7	23.8%

Spillover (Connectedness) Table

	edinburgh	e_lothian	midlothian	w_lothian	From Others
edinburgh	74.7	10.6	9.1	5.6	25.3
e_lothian	32.9	44.6	5.2	17.3	55.4
midlothian	45.4	7.4	44.0	3.2	56.0
w_lothian	31.1	19.3	10.4	39.2	60.8
Contribution to others	109.4	37.3	24.8	26.0	197.5
Contribution including own	184.1	81.9	68.8	65.2	49.4%

Spillover (Connectedness) Table

	glasgow	e_dunbartonshire	e_renfrewshire	renfrewshire	From Others
glasgow	77.5	8.7	3.4	10.3	22.5
e_dunbartonshire	21.9	71.2	4.2	2.7	28.8
e_renfrewshire	9.3	27.9	62.2	0.5	37.8
renfrewshire	22.9	18.9	11.6	46.7	53.3
Contribution to others	54.1	55.6	19.2	13.6	142.4
Contribution including own	131.6	126.7	81.4	60.3	35.6%

House Price Return Spillovers Bristol & Birmingham 1995-2019

Spillover (Connectedness) Table

	bristol	s_gloucestershire	From Others
bristol	85.9	14.1	14.1
s_gloucestershire	64.6	35.4	64.6
Contribution to others	64.6	14.1	78.8
Contribution including own	150.5	49.5	39.4%

Spillover (Connectedness) Table

	birmingham	dudley	sandwell	solihull	walsall	wolverhampton	From Others
birmingham	81.4	8.6	2.9	4.5	0.8	1.8	18.6
dudley	49.9	34.2	2.6	5.0	2.1	6.2	65.8
sandwell	52.6	9.7	32.1	0.7	1.7	3.2	67.9
solihull	48.8	7.6	2.1	38.5	0.7	2.2	61.5
walsall	46.1	8.4	5.3	3.4	32.4	4.3	67.6
wolverhampton	42.4	14.7	5.8	5.2	1.1	30.8	69.2
Contribution to others	239.8	49.0	18.8	18.8	6.5	17.8	350.6
Contribution including own	321.2	83.2	50.8	57.3	38.9	48.5	58.4%

House Price Return Spillovers Manchester 1995-2019

Spillover (Connectedness) Table

	manchester	bolton	bury	oldham	rochdale	salford	stockport	tameside	trafford	From Others
manchester	32.5	15.4	15.8	10.5	3.6	9.9	8.4	0.3	3.5	67.5
bolton	14.9	49.9	8.0	9.7	1.9	9.7	3.7	1.0	1.3	50.1
bury	39.4	10.1	23.4	6.8	2.4	7.8	7.1	0.9	2.1	76.6
oldham	29.8	16.7	11.8	31.3	1.4	2.8	1.0	4.6	0.5	68.7
rochdale	27.2	6.9	13.7	8.9	34.6	2.0	2.9	0.5	3.2	65.4
salford	14.5	14.9	13.5	20.1	7.2	19.5	1.4	4.1	4.8	80.5
stockport	42.5	11.9	16.6	7.0	5.3	8.8	5.4	0.9	1.7	94.6
tameside	23.4	22.4	4.4	16.9	2.8	8.8	10.0	8.3	2.8	91.7
trafford	29.4	23.3	13.3	6.4	3.7	7.3	8.6	1.0	6.9	93.1
Contribution to others	221.1	121.8	97.2	86.3	28.1	57.2	43.1	13.3	20.0	688.1
Contribution including own	253.6	171.7	120.6	117.7	62.7	76.7	48.5	21.6	26.9	76.5%

House Price Return Spillovers Newcastle & Nottingham 1995-2019

Newcastle

Spillover (Connectedness) Table

	newcastle	gateshead	n_tyneside	s_tyneside	From Others
newcastle	80.3	1.4	3.7	14.6	19.7
gateshead	27.9	53.2	9.5	9.4	46.8
n_tyneside	51.0	11.5	24.8	12.7	75.2
s_tyneside	29.4	20.9	10.8	38.9	61.1
Contribution to others	108.3	33.8	24.0	36.7	202.7
Contribution including own	188.6	87.0	48.8	75.5	50.7%

Nottingham

Spillover (Connectedness) Table

	nottingham	broxtowe	erewash	gedling	rushcliffe	From Others
nottingham	59.6	18.8	5.7	15.2	0.8	40.4
broxtowe	25.1	49.9	4.5	16.3	4.2	50.1
erewash	35.3	10.7	41.7	11.5	0.8	58.3
gedling	27.5	15.3	1.9	52.7	2.6	47.3
rushcliffe	18.0	27.6	2.6	11.7	40.0	60.0
Contribution to others	106.0	72.3	14.7	54.7	8.4	256.2
Contribution including own	165.6	122.2	56.4	107.4	48.5	51.2%

Results Summary

The value of the spillovers varies from 23.8% (Aberdeen) to 76.5% (Manchester) between the city and respective surrounding municipalities.

The second lowest spillover is 35.6% for Glasgow, followed by Bristol at 39.4%

Aberdeen and Bristol have urban areas mostly contained within their city (municipality) boundaries. Their hinterlands (contiguous municipalities) are much less urbanised.

Edinburgh, Newcastle, and Nottingham have spillover values of 49.4%, 50.7%, and 51.2% respectively. These cities have relatively tightly drawn boundaries and Newcastle and Nottingham have contiguous urban areas in other municipalities. While Edinburgh's urban area is mostly within its council boundaries, significant numbers of households live in and commute from the contiguous municipalities, particularly West Lothian.

Birmingham and Manchester whose spillovers are 58.4% and 76.5% respectively also have urban areas that spread into neighbouring municipalities. These are the largest conurbations in our sample with Manchester being relatively small compared to its neighbouring urban municipalities, whereas Birmingham is relatively large.

Conclusions

This is one of the few papers to consider disaggregating analysis to local authority (municipality) level and possibly the first to analyse spillovers at this spatial scale.

It might be expected, a priori, that connectedness would be greater across individual city regions than across regions at national level.

However this is not the case.

While Antonakakis et al (2018) find a total connectedness of 83.9% across UK regions, this exceeds the highest connectedness we find (in the case of Manchester) while most of our results suggest lower levels of total return spillovers.

It is possible that regional level data masks the heterogeneity that may exist when comparing housing markets at a more disaggregated level.

Our next steps will consider how connectedness varies over time and if receivers and recipients of shocks change over time.