Examining the persistence of housing submarket price differences

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Abstract

Although there is a vast literature examining the structure and operation of urban housing markets, analysis of the temporal properties of submarket structures and prices have been rare. As such, our understanding of the dynamics of submarket structures is limited. In this paper, we set out to a method for analysing submarket price changes. We construct repeat sales indices for six submarkets within Glasgow, Scotland for the period from 1984 to 1997. We use these indices to examine the trends in submarket prices and to consider whether price diffentials have been eroded over time. Using cointegration analysis, the empirical part of the paper shows that submarket-specific price differences persist over time and that a relatively stable submarket structure persists throughout the study period

1. Introduction

The aim of this paper is to consider internal structural change in a local urban housing market. This is undertaken by focusing on the stability of housing submarkets in terms of both their housing stock and house price trends. The empirical research is based on the owner occupied housing market in Glasgow, Scotland. The paper is organized as a series of steps. First, we briefly summarize the theoretical base for submarkets, standard testing procedures and research on the temporal change of submarkets. The following sections set out the research objectives, data sources, research method and detail the empirical research. In the concluding section, we reflect on the empirical results.

2. The nature of submarkets

The concept of the housing submarket was adopted as a working framework in a number of local housing market studies in the 1950s and 1960s (see inter alia Fisher and Winnick, 1953, Grigsby, 1963). In these studies submarkets were comprised of dwellings that represented relatively close substitutes to potential purchasers. The term has been widely adopted in the housing literature subsequently. Since the 1970s a range of over twenty studies have sought to confirm the existence of, and define the dimensions, of submarkets using hedonic house price analysis (see Watkins, 1998 for a comprehensive review). The principal message that emerges from this approach is that submarkets exist where the price of a standardized dwelling differs from other parts of the market. Prices will, however, be the same within submarkets. In a well functioning market price differences will be removed by the process of arbitrage as developers build in high price areas or sectors to take advantage of higher than normal profits or households relocate to take advantage of lower prices. Submarkets are likely to be observed where market imperfections, including search costs, transaction costs, imperfect information (caused, perhaps, by stock heterogeneity) and inelastic supply (caused by construction lags or planning constraints, for example), restrict the arbitrage process.

Some empirical studies of submarket existence and definition have assumed that spatial characteristics are more important than structural characteristics in the determination of submarkets (see Palm, 1978; Goodman, 1981; Michaels and Smith, 1990). In other studies, submarket structures have been proposed which are based on the identification of distinct sub-groups of demanders. Implicitly buyer sub-group preferences are based on their view of the spatial and structural characteristics of available housing units (Schnare and Struyk, 1976; Munro, 1986; Allen et al, 1995). Meanwhile, Rothenberg *et al* (1991) define submarkets according to 'hedonic quality'. They argue that the housing market is characterized by segmented demand and differential supply, a consequence of stock heterogeneity, spatial immobility and durability. The implication is that the market is comprised of an aggregation of non-competing submarkets. More recently, analysts have explicitly acknowledged the importance of both spatial and structural factors and segmentation of supply and demand in determining submarket dimensions (Maclennan and Tu, 1996; Adair *et al*, 1996).

The standard statistical test applied in many of these hedonic studies was developed by Schnare and Struyk (1976). The existence of statistically significant different constant quality housing price differences between *a priori* submarkets is taken as corroboration of submarket existence. This test is static both in nature and by the assumption of equilibrium in hedonic analysis. Yet, Grigsby (1963: 37-38) argued that relationships between submarkets are likely to be "...in a continual state of flux...". Recently, Bourassa *et al* (1999) highlight the need to test whether the boundaries of submarkets are stable over time.

It is clear that the submarket system is difficult to examine empirically, especially as the market is constantly changing. This is exacerbated by the standard methods deployed in testing for submarket existence. The need to repeat this static analysis over time is often defeated by the paucity of available data although there are some exceptions (see for example Hancock and Maclennan, 1989).

In their theoretical account of submarket change, Maclennan and Tu (1996) distinguish between short run and long run dynamic change in local housing markets. They argue that, in the short run, physical attributes and quality are fixed and prices will fluctuate in response to changing market conditions. In the long run, physical structures can also be changed and, as such, submarket composition may also alter.

This has a resonance with Rothenberg *et al*'s (1991) argument that submarkets are function of differences in 'hedonic' qualities. As such, it is suggested that submarket composition will change as stock undergoes conversion or depreciation or as new construction flows onto the market. However, such changes are not accommodated in their empirical exploration of the model. Similarly, despite their theoretical explanation of compositional change, Maclennan and Tu (1996) are forced to assume a stable submarket structure in their empirical analysis.

To summarize there is now a considerable literature which examines the existence and identification of submarkets. In the main these studies apply a standard set of static statistical tests based on the existence of price differentials, where the hedonic analysis used implicitly presumes equilibrium in each submarket. Furthermore, the use of hedonic analysis constrains the research to a static perspective, or at best a set of static pictures through time. There is a case that the boundaries or definitions of submarkets are not necessarily stable over time. On the other hand, for submarkets to be a meaningful research tool then logically they should show some stability over time, and any stock changes could only alter a submarket system in the long term.

3. Research objectives, methods and data

This paper accepts at the outset the existence of *spatial* submarkets (which may have nested within them structural submarkets) and that there is the potential for dynamic change. The dynamic change arises through supply changes via new house building or transfers from social rented housing to owner occupation. The essential core of the research is to assess the extent of submarket stability and to relate it to housing stock changes.

The null hypothesis to be tested is that stock changes that occur in established urban submarkets do not alter the basic structure of submarkets but give rise to price equalization in the long run. The statistical test for this occurrence is that real house price indices between submarkets are cointegrated. The first step in the empirical analysis is to identify a system of spatial submarkets and quantify changes to the housing stock over time. The period of the study is 1984-97.

The next steps are to quantify house price trends between these submarkets. Rather than cross-sectional hedonic analyses, the approach taken is to examine repeat sales indices over time. The final step in the empirical analysis is to test for stability between sub-markets. This is undertaken using cointegration between pairs of repeat-sales (RS) submarket indices using the Engle and Granger and the bivariate/multivariate Johansen approaches.

The empirical analysis is based on the owner occupied housing market in Glasgow, Scotland. This accounts for approximately 41% of households in the city. In the UK tenants of some social housing have had the 'Right to Buy' their homes at a discount below market value since 1980. This has increased the owner occupied housing stock but the impact on the market has lagged behind since sales were only to sitting tenants (ie non-market transactions). There was little impact on the market until resales increased in the early 1990s; subsequently accounting for more than 10 per cent of the market (Jones and Murie, 1999).

The starting point for local housing market analysis is the identification of a market area that is a functional economic entity. In previous research into the housing market in west central Scotland, Jones (2002) sought to determine functional housing market areas. Using a 'bottom up' approach, they applied an algorithm to data on migration patterns to group settlements into housing market areas so that the majority of buyers will have moved from within the areas' boundaries. Based on a 50% self containment benchmark, twenty-three market areas are uncovered. The empirical analysis in this paper concerns Glasgow, one of the twenty-three market areas identified by Jones (2002) and the dominant urban housing market in the West of Scotland.

The next stage in the analysis requires an initial system of spatially defined submarkets. In this study our submarkets were derived using the standard cross-sectional test procedures described in section two. Using data on 544 transactions from 1991, six submarkets were identified. The statistical analysis showed evidence of significant differences in the price paid for dwellings of a standard hedonic quality[1]. The submarkets are defined in table 1. They are really contiguous groupings of postcode sectors. Although postcodes can be arbitrary, the contiguous groupings in this case clearly fit identifiable subsets of the market.

[1] Detailed results of this analysis are available from the authors.

The data for the analysis is extracted from the public Register of Sasines and the Scottish Land Registry via the Land Value Information Unit (LVIU) at the University of Paisley. The LVIU maintains an electronic database of publicly-available real estate transactions including prices, addresses and unique property identifiers. The data also allow the identification of new-build sales, non-market sales and discount sales by the public sector to sitting tenants.

The RS indices are estimated following the methodology set out by Bailey *et al* (1963). We employ the correction for heteroskedasticity suggested by Case and Shiller (1987). Following estimation we use the coefficients to construct a cumulative price index and deflate it using the retail price index (RPI).

The method proved highly efficient in terms of data usage. There were a total of 282,099 recorded transactions in Glasgow between 1984 and 1997 with the number of transactions each year ranging between 12,000 and 35,000 with a mean of 20,150. A total of 47,430 repeat sales were identified (28% of all recorded transactions). Table 1 reports the number of repeat-sales identified in each submarket:

Table 1 Definition of submarkets and number of identified repeat-sales

Submarket	Area	Number of matched repeat-sales
1	City Centre	2,669
2	West	5,778
3	North West	739
4	East	2,114
5	South	9,705
6	South West	2,710

4. Changes to the housing stock

In section 2 we noted that submarket composition is likely to change in the long run as a consequence of spatial arbitrage and differential rates of new construction. This section examines additions to the housing stock through new construction and sales of social housing to sitting tenants.

The annual changes to the housing stock for each submarket, arising from new building and transfers from the social rented sector, over the period 1984-1998 are presented in Table 2. The picture is one of incremental change, although the total change for the smaller submarkets represents a considerable proportional increase: 34% for the city centre and the north west, and 25% for the south west. The most established areas of the owner occupied housing market within the city in terms of scale, price and lack of social rented housing experienced only modest relative increases: 13% in the west and 7% in the south. The east with a predominance of low priced housing also shows only a modest increase in its stock of 11%.

Table 2 Annual changes in the housing stock of submarkets

Year	C	W	NW	E	S	SW
83	3,432 -	22,311 -	7,553 -	10,879 -	28,260 -	9,575 -
84	3,432 (0)	22,311 (0)	7,553 (0)	10,879 (0)	28,260 (0)	9,575 (0)
85	3,432 (0)	22,358 (0.2)	7,632 (1)	10,911 (0.3)	28,266 (0)	9,730 (1.6)
86	3,432 (0)	22,362 (0)	7,634 (0)	10,912 (0)	28,267 (0)	9,732 (0)
87	3,432 (0)	22,374 (0.1)	7,636 (0)	11,029 (1.1)	28,274 (0)	9,739 (0.1)
88	3,658 (6.6)	22,391 (0.1)	7,639 (0)	10,918 (-1.0)	28,285 (0)	9,754 (0.2)
89	3,820 (4.4)	22,437 (0.2)	7,791 (2.0)	11,070 (1.4)	28,565 (1.0)	9,932 (1.8)
90	3,967 (3.8)	22,762 (1.4)	8,015 (2.9)	11,157 (0.8)	28,734 (0.6)	10,208 (2.8)
91	4,061 (2.4)	22,947 (0.8)	8,278 (3.3)	11,257 (0.9)	28,850 (0.4)	10,463 (2.5)
92	4,155 (2.3)	23,167 (1.0)	8,491 (2.6)	11,362 (0.9)	28,996 (0.5)	10,710 (2.4)
93	4,225 (1.7)	23,552 (1.7)	8,803 (3.7)	11,493 (1.2)	29,135 (0.5)	10,996 (2.7)
94	4,294 (1.6)	23,984 (1.8)	9,093 (3.3)	11,604 (1.0)	29,288 (0.5)	11,284 (2.6)
95	4,367 (1.7)	24,538 (2.3)	9,379 (3.1)	11,821 (1.9)	29,470 (0.6)	11,485 (1.8)
96	4,479 (2.6)	24,870 (1.4)	9,669 (3.1)	12,038 (1.8)	30,059 (2.0)	11,648 (1.4)
97	4,592 (2.5)	25,163 (1.2)	10,040 (3.8)	12,076 (0.3)	30,208 (0.5)	11,952 (2.6)
98	4,611 (0.4)	25,267 (0.4)	10,109 (0.7)	12,103 (0.2)	30,231 (0.1)	11,980 (0.2)
Total	(34.4)	(13.2)	(33.8)	(11.3)	(7.0)	(25.1)

Notes: Figures in brackets are percentage annual changes; No RTB adjustment for 97/98

5. Tests for cointegration

In this section of the paper we present the findings of the empirical analysis of submarket house price dynamics. As we argued earlier, spatial arbitrage and differential rates of new construction between submarkets are likely to change the submarket structure in the long run. An important *caveat* is that, on the supply side, an adequate land supply and sufficiently flexible planning policies are required to permit building firms to capitalize on spatial submarket price differences in the short-run.

This section presents results of cointegration tests on the submarket price indices of the six spatial submarkets identified in earlier static analysis. The estimated RS price indices are deflated using the quarterly retail price index (RPI). Prior to the cointegration analysis unit root tests are carried out on the real RS house price indices:

Table 3 Augmented Dickey-Fuller test results

	level	1st diff.	Order of integration
C	-2.35473	-5.9528	1
W	-1.62757	-5.18711	1
NW	-1.74319	-6.70481	1
E	-2.36604	-8.75026	1
S	-2.26809	-5.77554	1
SW	-2.27659	-6.60576	1

Critical values: 1% -3.5745, 5% -2.9241

Table 4 Phillips-Perron test results

	level	1st diff.	Order of integration
C	-1.41323	-12.7541	1
W	-1.75542	-9.43096	1
NW	-2.59215	-12.5447	1
E	-2.09066	-10.4663	1
S	-1.81367	-9.60183	1
SW	-2.7499	-10.1493	1

Critical values: 1% -3.5713, 5% -2.9228

The augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (tables 3 and 4) show that the null hypothesis of no unit root can be rejected at the 1% level in all cases. Since each of the series has a unit root in levels but not first differences, all series are I(1) and it is appropriate to employ cointegration methods.

Initially, the tests for cointegration between submarket indices use the Engle and Granger method (Engle and Granger, 1987). This method tests for cointegration between a pair of series by estimating a cointegrating regression and testing the residuals for stationarity. If a linear combination of two non-stationary price indices is stationary then we can say that the indices are cointegrated.

There are two parts to the cointegration test. First, the Durbin-Watson (DW) statistic is examined. If the DW statistic exceeds the critical value then the hypothesis of no cointegration should be rejected. Second, an augmented Dickey-Fuller (ADF) test is performed on the series of residuals from the cointegrating regression. If the ADF statistic reveals that the series of residuals contains a unit root then the hypothesis of no cointegration cannot be rejected.

As there are 6 submarkets it is necessary to estimate 30 cointegrating regressions. Table 5 shows the DW statistics from the 30 cointegrating regressions and Table 6 shows the ADF statistics for the resultant series of residuals. For simplicity in interpretation the results are combined in table 7.

Table 5 Durbin-Watson statistics for cointegrating regressions

DW	Dependant					
SM	C	W	NW	E	S	SW
C		2.0274	1.2963	1.0468	1.1354	0.7186
W	2.1171		1.2653	0.9160	0.9908	0.6546
NW	1.0148	0.8941		1.8467	1.4947	1.6683
E	0.9145	0.6941	1.9960		1.3416	1.4796
S	1.1758	0.9415	1.8167	1.5143		0.8466
SW	0.4270	0.2733	1.6582	1.3203	0.5145	

Critical values: 1% 0.511, 5% 0.386, 10% 0.322

The Durbin-Watson statistics indicate that the hypothesis of no cointegration should be rejected for 29 of the 30 combinations of submarket price indices. The hypothesis is rejected at the 1% level of significance for 28 of these combinations. The exception is for the cointegrating regression of submarket W on submarket SW. However, it should be noted that the hypothesis of no cointegration is rejected on the basis of the DW statistic for the cointegrating regression of submarket SW on submarket W.

Table 6 ADF Statistics for the residuals of the cointegrating regressions

ADF	Dependant					
SM	C	W	NW	E	S	SW
C		-5.2350	-2.2335	-1.5362	-2.6764	-1.3917
W	-4.5448		-1.2351	-1.5354	-1.5254	-1.1059
NW	-2.2559	-1.8365		-4.9720	-3.1984	-2.7553
E	-2.0957	-2.5026	-5.4114		-4.0339	-3.6370
S	-2.5754	-1.9417	-3.0280	-3.4169		-1.8131
SW	-1.9559	-2.1182	-3.3068	-3.7874	-2.3575	

Critical values: 1% -3.5745, 5% -2.9241, 10% -2.5997

The results of the ADF tests show that the hypothesis of no cointegration should be rejected for 13 of the 30 combinations at the 10% level of significance or better. For 2 of the combinations the hypothesis can only be rejected at the 10% level while only 7 are rejected at the 1% level of significance. The results are summarized in Table 7 below. Each cell in Table 7 shows the level of significance at which the hypothesis of no cointegration is rejected for both cointegrating regressions of a pair of submarket indices. Cell (C,W) shows the level of significance for the rejection of the hypothesis for the cointegrating regression of submarket C on submarket W and of submarket W on submarket C.

Table 7 Summary of results: rejection of hypothesis of no cointegration

SM	C	W	NW	E	S	SW
C		1%, 1%	-	-	10%, -	-
W	1%, 1%		-	-	-	-
NW	-	-		1%, 1%	5%, 5%	10%, 5%
E	-	-	1%, 1%		5%, 1%	1%, 1%
S	10%, -	-	5%, 5%	5%, 1%		-
SW	-	-	10%, 5%	1%, 1%	-	

As Table 7 shows, the combined results of the DW and ADF tests indicate that, at the 5% level or better, 5 pairs of submarket indices are cointegrated. Meanwhile the remaining 10 pairs of submarket real price indices are not cointegrated.

In order to test the robustness of these results, the analysis is repeated using the Johansen (bivariate) method. The bivariate Johansen approach is used to test the null hypothesis that there are no cointegrating vectors in a specified system. The test is performed for each combination of pairs of submarket price indices (a total of 15 combinations). Unlike the Engle and Granger method which uses OLS, testing for cointegration using the Johansen method requires the estimation of VARs. Since this is the case the Johansen test for cointegration requires that the VAR lag structure be specified at the outset.

Given that our analysis considers the dynamics of local housing market price trends price adjustments within and between submarkets are likely to take place within a relatively protracted period. In order to determine the correct lag length, different specifications of VAR were estimated for all the submarket and neighbourhood real price indices. The appropriate lag length is selected on the basis of that which minimizes the Akaike Information Criteria.

Table 8 Akaike Information Criteria; various lag specifications

	Akaike Information Criteria					
Lags → (quarters)	1	2	3	4	5	Minimum
Submarkets						
C and W	-7.79604	-7.93244	-7.83538	-7.76178	-7.68212	2
C and NW	-6.74388	-7.0795	-6.94661	-6.94076	-7.03148	2
C and E	-7.48105	-7.80884	-7.90151	-7.85989	-7.89106	3
C and S	-7.78372	-8.0289	-7.91225	-7.89482	-7.97459	2
C and SW	-7.37024	-7.75111	-7.5669	-7.485	-7.33344	2
W and NW	-7.14331	-7.33144	-7.20598	-7.13886	-7.13968	2
W and E	-7.78765	-7.74986	-7.85576	-7.96995	-7.86323	4
W and S	-8.02201	-8.1552	-8.04005	-7.90442	-7.96097	2
W and SW	-7.90032	-7.9679	-7.86653	-7.67821	-7.71622	2
NW and E	-7.75052	-7.77328	-8.02535	-8.21685	-8.14818	4
NW and S	-7.5513	-7.5684	-7.48745	-7.41932	-7.21262	2
NW and SW	-7.51507	-7.47537	-7.46885	-7.39324	-7.22431	1
E and S	-8.25676	-8.23845	-8.35697	-8.36353	-8.32415	4
S and SW	-8.2586	-8.12416	-8.27488	-8.32091	-8.39551	5

Table 9, below, reports the results of the cointegration tests using the bivariate Johansen method. In performing the tests it is assumed that the cointegrating equations have an intercept but no trend. The VARs are specified with a lag structure as indicated by the AIC shown in table 8 above.

Table 9 LR tests for Null Hypothesis of No Cointegration (2 lags)

	H_0: r = 0		H_0: r <= 1	
C and W	24.7115	*	3.5225	
C and NW	11.9437		4.1738	**
C and E	8.170827		0.171748	
C and S	13.1361		3.935	**
C and SW	9.0487		1.4631	
W and NW	6.1255		0.6791	
W and E	6.992573		0.753724	
W and S	5.489		0.4975	
W and SW	7.0972		0.0501	
NW and E	17.81927	*	3.898314	*
NW and S	13.1762		2.7116	
NW and SW	14.36376		3.289793	
E and S	11.014		4.4753	**
E and SW	5.731831		0.266283	
S and SW	15.20764		3.53523	

** denotes significant at the 1% level * denotes significant at the 5% level

Table 9 shows the null hypothesis of no cointegrating vectors is rejected for only 3 of the fifteen paired combinations of submarket real price indices. These results are combined with the results of the Engle and Granger cointegration tests and reported in Table 10 below.

Table 10 Summary of Results: cointegration between submarket indices

SM	C	W	NW	E	S	SW
C		E, J				
W	E, J					
NW				E, J	E	
E			E, J		E	E
S			E	E		
SW				E		

E signifies that the submarket price indices are cointegrated using the Engle and Granger method
J signifies that the submarket price indices are cointegrated using the bivariate Johansen method

The results of the bivariate Johansen tests for cointegration verify the results obtained by the Engle and Granger method. Using the Johansen method the null hypothesis of no cointegration is rejected for 2 rather than 5 of the 15 pairs of indices. These 2 pairs of indices are also found to be cointegrated applying the Engle and Granger method. The submarket pairs, C and W and E and NW, are also adjacent contiguous submarkets. Hence if we apply cointegration as a test of submarket existence then the spatial submarket system collapses from six to four. A separate study of the Glasgow housing market shows that Central and West End are part of the same submarket (Watkins, 2001).

As a final check on the results we employ a test for cointegration using the multivariate Johansen approach. Clearly, our expectation here is to discover that there are three cointegrating vectors in the system of six submarket indices.

Table 11 LR tests for Null Hypothesis of No Cointegration (2 lags)

	Hypothesized number of cointegrating equations					
	0	<=1	<=2	<=3	<=4	<=5
Likelihood Ratio	121.357	77.982	47.570	18.270	6.038	0.004
	**	**	*			
1% Critical Value	103.18	76.07	54.46	35.65	20.04	6.65
5% Critical Value	94.15	68.52	47.21	29.68	15.41	3.76

** denotes significant at the 1% level * denotes significant at the 5% level

The results indicate that the system contains three cointegrating equations at the 5% level of significance. This is in keeping with expectations.

6. Housing stock changes and long run house price dynamics

Comparison of the cointegration analysis results with the earlier analysis of housing stock changes yields some interesting findings. The housing stocks of submarkets Central and West (whose indices are cointegrated) increased by 34.4% and 13.2% respectively. An analysis of average household migration between submarkets over the study period (shown in table 12 below) shows that self-containment in the Central submarket is low (32%) while almost 11% of buyers originated in the West submarket.

However, this pattern is not mirrored in the migration figures between submarkets East and Northwest. Migratory linkages are not particularly pronounced although there is also a disparity in the housing stock changes between these two submarkets. Finally, the South and Southwest submarkets are the most self-contained of the six. They are also the only submarkets whose price indices are not cointegrated with another submarket.

Table 12 Migratory self-containment in Glasgow 'submarkets'

	Origin					
Destination	C	W	NW	E	S	SW
C	**32.0**	10.8	5.2	2.0	3.8	0.8
W	3.8	**57.3**	4.6	0.8	3.0	1.1
NW	4.3	9.0	**58.6**	1.8	2.4	0.9
E	2.8	3.6	4.7	**52.0**	4.1	1.3
S	1.5	3.5	2.2	1.5	**58.5**	3.8
SW	1.3	2.9	2.2	0.7	9.5	**65.9**

Figures show percentage of transactions in 'Destination' submarket where the purchaser originated in the 'Origin' submarket

7. Conclusions

The analysis of internal structural change in a local urban housing market is considered here through a system of submarkets. This is undertaken by focusing on the stability of housing submarkets in terms of both their housing stock and house price trends. There is now a general acceptance of the existence of submarkets. Submarket studies have generally applied hedonic price analysis using a standard set of statistical tests based on the existence of price differentials. This approach faces a number of constraints: the hedonic analysis implicitly presumes equilibrium in each submarket and these cross-sectional studies by definition limit a dynamic perspective, even with repetition of the analysis at different points in time.

As such, analysis of the stability of submarkets over time requires a new approach. This paper begins with a set of spatial submarkets identified using standard static tests but accepts that there is the potential for dynamic change. This dynamic stems from supply changes via new house building or transfers from social rented housing to owner occupation. The basic goal of the paper is primarily to assess the significance of submarket instability and, second, to relate it to stock changes and, to a lesser extent, to household intra-urban migratory patterns.

The null hypothesis tested is that stock changes in established urban submarkets do not alter the basic structure of submarkets but give rise to price equalization in the long run. This proved not to be the case over the period 1984-1997. The results of the cointegration analysis show that the price indices of only two pairs of submarkets are cointegrated. This implies that the system of six submarkets identified in the static analysis collapses to a system of four submarkets in the long run. The use of cointegration methods is, in effect, a new test for submarket persistence.

To conclude, this paper establishes a strong case for the existence of spatial submarkets and their stability over time. This is despite considerable (though not spatially uniform) new building which has dramatically changed certain neighbourhoods. This evidence perhaps leaves a conundrum about the role of supply constraints in the creation of submarkets. Despite the fact there has been considerable change in the stock, submarkets have perpetuated. This may be partly explained by the differential spatial impact of new building which has had least effect on the largest submarkets.

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