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Bubbles, Busts and Breaks in UK Housing

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Since the recent turmoil in UK housing, there has been controversy over whether house prices in the past decade have entered a bubble. While there are numerous techniques employed to investigate the presence of bubbles, testing the significance of breaks in the dynamics of prices has been utilized in other research to detect such bubbles. This is important in itself, as changing parameters in housing time series models make forecasting and portfolio management more difficult.

We examine thirteen regions of the UK as well as the national home prices. The results indicate that while there were some breaks over the 2000s, more regions (and the UK as a whole) experienced breaks over the late 1980s and early 1990s. These results indicate that while there have been large price swings over the past decade, the late 1980s/early 1990s, which followed sharp changes in housing, monetary and fiscal policies, appear to be the larger boom-bust episode.

Keywords

Bubbles, Structural Breaks, UK Home Prices

1. Introduction

Over the last several decades, UK house prices have experienced a number of large swings. The latest episode, in which house prices started to fall in 2007 after a decade - long rise, was part of a pattern of house price swings that was international in scope and followed by the global financial crisis. Some observers have presented evidence that suggest UK house prices over the past decade exhibited bubble behavior - that is, by the definition of a bubble, UK house prices may have risen to higher levels than could be justified by fundamentals. Others, however, disagree, and claim there is little credible evidence that home prices rose faster than could be justified by underlying determinants over the past decade. In particular, by employing different methodologies, some researchers find evidence that support a bubble in UK housing in the 2000s decade (Zhou and Sornette (2003), Barrell et al. (2004), OECD (2005)) while others argue this was not the case (Nickell (2005), Cameron et al. (2006)).

Dramatic price changes, such as bubbles, can induce parameter change in empirical house price models. Indeed, two papers on the American housing market over the 2000s (Wheaton and Nechayev, (2008), Canarella and Pollard (2010)) both examine home price indices for variants of structural breaks in attempts to discern whether there was a housing bubble in the US. The purpose of this paper is to investigate UK house prices, at both the regional and national levels, for such breaks to discern the periods in different regions, as well as the overall UK, that most likely entered into bubbles.

As noted, previous papers have investigated bubble and bust cycles by testing for breaks in the US; another paper (Pain and Westaway (1997)) employs dummy variables to capture speculative behavior in the UK housing market. An issue is that the way in which these breaks are analyzed is problematic. As we will discuss further, these methods tend to result in incorrectly inferring that a break exists when in fact none may have occurred. Accordingly, we will apply two techniques which have been specifically developed to avoid such problems.

Moreover, the investigating of such empirical asset price models for structural change is important for portfolio management in its own right. Parameter change can lead to forecasting error, thus frustrating efforts at risk management. Clements and Hendry (1998) detail a list of forecasting failures for other macroeconomic series in the UK which have resulted from failure to detect structural breaks in empirical models. A related point is the importance of properly testing for structural change - many previous methods have been employed in economic and financial research which have led to false conclusions with regard to the existence of breaks. Some papers that deal with the UK housing market and some potential bubble episodes have employed techniques which can lead to erroneous inference. More modern

techniques with proper size and critical values have been developed in more recent years, and we will apply these tests to UK housing.

To anticipate our results, we find that in most regions, as well as the UK as a whole, breaks have tended to occur in the late 1980s and early 1990s - more so than in the 2000s. This suggests that, while the price swings of the latest decade were undoubtedly dramatic, the greatest true structural change in overall house price dynamics was about twenty years earlier. Indeed, these results conform to intuition. The late 1980s was a period of major changes in the UK housing market, including both large interest rate movements and housing tax law changes. Moreover, the results are consistent with some of the previous research. Cameron et al. (2006), for instance, find no evidence of a bubble over the most recent decade, but cannot rule out a bubble in the late 1980s.

This paper proceeds as follows. The next section discusses the previous literature on bubbles and structural breaks in housing. The third describes our data and methodology. The fourth describes our results, and the fifth section concludes.

2. Previous Literature

A potential effect of bubbles is that they may cause parameter change in empirical forecasting models. Clements and Hendry (1998) state that parameter change is "probably the main cause of serious forecasting errors" (p. 168). The authors go on to discuss the failure of macroeconomic forecasting models in the UK because of major structural changes, and note that: "The historical record of periods of dramatic predictive failure suggests that, not surprisingly, a close association between poor forecast performance and episodes of economic turbulence…An econometric theory of economic forecasting must recognize the role of non - constancy to deliver relevant conclusions about empirical forecasting" (p. 168). Thus detecting parameter non-constancy is important, as it may yield information about when certain changes, such as bubbles - associated with the aforementioned economic turbulence - occurred. Moreover, it is important to investigate empirical models for change, since, as Clements and Hendry indicate, structural breaks cause poor prediction, thus making portfolio and risk management more difficult.

There have been important changes in British housing which can lead to booms, busts and parameter change. Muellbauer and Murphy (1997), for instance, state that "Theory suggests that financial liberalization of mortgage markets in the 1980s should have led to notable shifts in house price behavior" (p. 1701). Agnello and Schuknecht (2011) similarly point out that, according to their study of housing booms in eighteen countries, recent

housing booms have been more persistent than those in the past. One can thus infer, if this is the case, the dynamics of house prices may well have changed. Moreover, Andrew and Meen (2003) point to structural changes in the relationship between prices and transactions in the UK.

Despite all of the changes in the housing market, and the central role that the housing bust appeared to play over the 2007-09 downturn in many countries, there was still some controversy over whether house prices had truly entered a bubble in the UK over the 2000s decade. Research by Zhou and Sornette (2003), Barrell et al. (2004) and the OECD (2005) strongly suggests that house prices were indeed in bubble territory, while other analysts, such as Nickell (2005) and Cameron et al. (2006) argue that house prices, while rising, were reflecting the underlying fundamentals. There was of course a similar controversy over whether there was a housing bubble in the United States over this period (see Case and Shiller (2003) for a discussion of whether the US housing prices in the early 2000s reflected a bubble). To empirically investigate the extent to which house prices in the US were reflecting or rising above fundamental determinants, Wheaton and Nechayev (2008) gathered quarterly data from the Office of Federal Housing Enterprise Oversight (OFHEO) home price index on fifty-nine US metropolitan statistical areas (MSAs). In their observations that prices appear to have started to rise dramatically, starting in 1998, the authors regress house prices on a set of fundamentals such as employment, income and mortgage interest rates. The authors find that the fundamentals often severely under-forecast the price appreciation that occurred over 1998 - 2005. The extent of under-forecasting substantially varies across the MSAs, however. Upon analyzing the forecast errors, the authors find the residuals are the largest for larger municipalities, and appear to be larger where investment and second home buying are prevalent, and where sub-prime activity is most active.

The results of Wheaton and Nechayev are very interesting. They seem to correspond to intuition. At the same time, while US house prices did indeed rise, starting in 1998, the choice of that year may be problematic for making inference. Even if the rising prices which started in 1998 reflected a bubble, the late 1990s were years of strong growth and low unemployment. Moreover, other commentators believe the housing bubble started later than 1998. Taylor (2007) cites what he believes was the excessively loose monetary policy and low interest rates of the Federal Reserve, which he believes began in 2002. Other commentators (such as US Federal Reserve chairman, Alan Greenspan) believe that low interest did indeed blow up the bubble, but cite global factors such as strong demand for US treasuries from emerging markets. However, the timing of such low rates is similar to that of Taylor - the early to middle 2000s, rather than 1998.

In addition, the selection of a starting point, or a structural break in time because the date is “known” to be the start of major price changes or some other important change is statistically problematic. This is the way that

standard Chow-type tests are conducted; the researcher chooses a date, and allows some parameter or parameters in the model to vary in value before and after the specified date. If the fit of the model in which the break is allowed is significantly better than that in which parameter constancy is imposed, then it is standard practice to conclude that a break had indeed occurred at the chosen point. Hansen (1992) explains in detail that since the break point is chosen because it is "known" to have been a date of potentially important change, the choice of that date is the result of a form of data mining, and hence endogenous. Intuitively, if one was formally testing for break in prices, the true critical values for such a test would be much larger than standard t, F or chi-square tables would indicate.

This is not some inconsequential point of statistical theory. For instance, Alogoskoufis and Smith (1991) examine changes in U.S. inflation persistence that resulted from the dropping of exchange rate pegs. The authors find that episodes such the U.S. which left the gold standard and the collapse of the Bretton Woods system did appear to lead to large increases in inflation persistence. However, Burdekin and Siklos (1999) conjecture that events besides changing exchange rate pegs affect inflation as well. Upon testing different events for breaks, Burdekin and Siklos find that other events, such as oil price shocks, have larger effects than changes in exchange rates.

Intuitively, to avoid the problem of data mining and choosing break points based on prior knowledge, one could test all of the points (one might first trim the data set by dropping the first and last few observations) for a break, and choose, as the breakpoint, the date which yields the largest test statistic. This is the approach of Quandt (1960). However, this test statistic will not have a standard distribution, as the break is identified only under the alternative hypothesis. In addition, if one is using a nominal size of five percent, one is almost certain to reject the null hypothesis of no break, even when the null hypothesis is true, for any reasonably large data set. However, Andrews (1993) and Andrews and Ploberger (1994) have developed test statistics and Hansen (1997) has developed a bootstrapping procedure that yield critical values for this type of test which overcome the problems of Quandt (1960). The Andrews-Ploberger test employs an exponential transformation of the F-statistics. This procedure allows for tests of change in different parameters, such as the mean, persistence and residual variance of a model.

The Andrews -Ploberger test typically allows for only one break in a given series. This could lead to problematic inference if there is more than one break. In addition, the method only has reasonable power if the residuals from the regression model are white noise (see Eksi (2009, p. 6); this issue will also influence our choice of empirical models). Bai and Perron (2003) have developed a test for multiple breaks in a model. Eksi (2009) explains how the method of the authors begins by defining a minimum segment length, and then searching for the optimal break point based on this segment. Then additional breaks are investigated to see if they lead to an improvement in the

fit. Bai and Perron demonstrate the convergence and consistency properties of this sequential testing method.

Canarella and Pollard (2010) examine house prices in ten large U.S. municipalities (as well as the composite index for the entire country) by employing monthly data from 1987:1 to 2009:4. In investigating the possibility of unit roots, they employ a unit root test for the difference in the natural log of prices in the index. The test - the Lee and Strazicich procedure - allows for two structural breaks in the mean and trend of each series in determining whether a given return series for a city is stationary. The authors find that the return series are stationary. They also find significant breaks in these series. The breaks mostly first occurred in the early 1990s - during the 1990-1991 recession, and during the 2000s, over the recent run-up in home prices.

By employing an endogenous break test, the Canarella and Pollard (2010) paper is an important contribution, and by finding significant breaks in the 2000s, it bolsters evidence for a bubble in the US over this period. There is some legitimate concern over the nature of the breaks in the Lee and Strazicich procedure that they employ, however. The technique allows for changes in the intercept (mean) and linear trend of a series. However, to avoid false inference in testing for a structural change, it is important to allow for changes not just in the mean and trend, but also in persistence (the autoregressive parameters). Cecchetti and Debelle (2006) point out that testing for a change in the mean of a series without allowing for a change in persistence (or vice-versa) can lead to false inference.

Accordingly, we will employ techniques to the UK housing market which account for the endogenous nature of structural breaks, and in addition, allow for breaks in the mean, trend and variance, as well as in the persistence parameters of the series.

3. Data and Methodology

We will analyze the price indices of the Nationwide Building Society for the same thirteen regions - North, Yorkshire and Humberside, East Midlands, West Midlands, North West, East Anglia, Greater London, South East, Outer Southeast, South West, Wales, Scotland and Northern Ireland - which have been the focus of so many papers on UK house price dynamics (see, for example, Alexander and Barrow (1994), Cook (2003), Cook and Thomas (2003), Cook (2005), Cook (2006), Holmes and Grimes (2008), Miles (2011)) . We will allow each region to have potentially different inflation dynamics, rather than imposing one model on the whole country, since previous studies have indicated that dynamics are decidedly not identical across the UK (Alexander and Barrow (1994) and Holmes and Grimes (2008) present results that indicate non-negligible segmentation in the UK housing

market; thus different regions may exhibit bubble behavior and structural breaks at different times).

The data was obtained from the Nationwide Building Society. The data is quarterly, and runs from 1973:4 through 2011:1. In order to avoid potential problems that arise from non-stationarity or seasonality in the data, we will examine annual returns, measured as the difference between the log level of a given index and its log level four quarters earlier. All of the data are deflated by using the consumer price index (CPI) of the UK. Figures 2 through to 14 display these regional returns, and Figure 15 displays the returns on the UK national index. The next step is to develop time series models for all of the different regional price indices. Given the nature of the break tests, we will employ autoregressive (AR) models, as per Canarella and Pollard (2010). While there are a number of criteria (Akaike information criterion (AIC), Schwartz information criterion (SIC)) that might be employed, we follow the more conservative strategy of choosing the model that leads to no autocorrelation in the residuals. Autocorrelation in the residuals could bias the results of our structural change tests. Thus each region is allowed to have its own number of lags, as was the case in Canarella and Pollard (2010).

We will employ two types of tests. As noted, the first is the Andrews-Ploberger (1994) test. This procedure allows for one break for each parameter in the series (although all of the parameters - mean, trend, all of the AR parameters (persistence) and variance are allowed to display a break, and at different points), as well as one break for all of the parameters jointly. We will display the dates when the Andrews-Ploberger procedure resulted in a significant break in all of the parameters, and when it signified a break in the mean.

The second procedure is the Bai-Perron test. Like the Andrews-Ploberger procedure, it tests for endogenous breaks in a time series. Unlike the Andrews-Ploberger test, it allows for multiple breaks. There is a trade-off involved for proper inference in deciding the number of allowed breaks. Cecchetti and Debelle (2006) note that allowing for too few breaks when a process has undergone multiple changes can lead to false inference; by the same token, allowing for multiple breaks when a process has undergone only one change also leads to false conclusions. Given that the raw data points to three major boom and bust episodes over the sample, as will be discussed below, we will allow for three breaks in the Bai-Perron procedure. We will thus present both the Andrews-Ploberger results as well as the Bai and Perron results for comparison.

4. Results

Table 1 displays the summary statistics for the thirteen regions and the UK. A rough measure of the volatility of the returns of a region is given by the

coefficient of variation, or the standard deviation of returns for each region divided by the respective mean of each region. As Table 1 indicates, the most volatile region by this metric is Yorkshire and Humberside, followed by Northern Ireland, Wales and East Anglia. In contrast, London is the second *least* volatile region, while the Outer Metro and Outer Southeast regions are also below average in volatility. The "inverse" relationship between the "center" or urban regions and volatility is not precise, as Scotland exhibits the least variable returns in our sample. However, it does appear to be the case that more "peripheral" sections of the UK have greater average relative variability in returns compared to larger, more densely populated areas in and around London. The exact reasons for this are unclear and beyond the scope of this paper.

Table 1 Summary Statistics

	Mean	Max	Min	St. Dev	CV
East Anglia	0.022	0.344	-0.27	0.121	5.5
East Midlands	0.0211	0.385	-0.219	0.11	5.21
London	0.03	0.241	-0.258	0.117	3.9
Northern Ireland	0.0197	0.426	-0.457	0.124	6.29
North	0.0197	0.309	-0.197	0.098	4.97
Northwest	0.023	0.337	-0.195	0.099	4.3
Outer Metro	0.0257	0.234	-0.249	0.113	4.39
Outer Southeast	0.0247	0.255	-0.264	0.118	4.77
Scotland	0.0199	0.204	-0.164	0.0711	3.57
Southwest	0.0256	0.324	-0.199	0.11	4.29
Wales	0.019	0.366	-0.23	0.108	5.68
West Midlands	0.02	0.352	-0.215	0.104	5.2
York. & Humb.	0.017	0.373	-0.303	0.11	6.47
UK	0.022	0.228	-0.21	0.097	4.4

Note: The numbers display the mean, maximum, minimum, standard deviation and coefficient of variation of returns for each UK housing price index, as measured by the log change between each index in a given quarter and the level of the index four quarters earlier.

Further results for the thirteen UK regions, as well as the national UK index, are displayed in Table 2. The column labeled "AR lag" shows the number of AR lags included in the model of each region that led to no autocorrelation in the residuals. The column "AP: All Coefficients" displays the date (if any) on which there was a significant break in all of the coefficients of a given region by the Andrews-Ploberger test. The column "intercept" shows the date, if any, of a significant break in the mean (intercept) for a given region by the Andrews-Ploberger test. The final two columns exhibit the two most likely break dates chosen by the Bai-Perron procedure.

Table 2 Break Test Results

	AR lag	AP: All Coefficients	Intercept	BP_1	BP_2	BP_3
East Anglia	6	None	None	1988:3	1990:3	2007:4
East Midlands	6	None	None	1988:1	1989:3	2004:1
London	5	None	None	1987:3	1990:4	2007:4
Northern Ireland	5	2003:4	None	1992:1	2005:3	2008:4
North	5	None	None	1989:4	1996:1	2004:1
Northwest	9	None	None	1988:2	1992:1	2004:2
Outer Metro	6	None	None	1979:4	1998:1	2004:3
Outer Southeast	6	None	None	1987:4	1990:4	1999:3
Scotland	5	None	None	1989:4	1997:1	2008:1
Southwest	6	None	None	1987:4	1989:3	1995:1
Wales	5	None	None	1987:4	1989:2	1995:1
West Midlands	7	None	None	1978:3	1987:4	1990:3
York. & Humb.	6	None	None	1988:1	1990:4	2004:1
UK	6	1985:1	None	1979:4	1987:4	1990:4

Note: AR Lag refers to the number of lags included in the model to obtain no autocorrelation in the residuals. The columns labeled AP: All Coefficients and Intercept display the test results for the Andrews-Ploberger tests for structural breaks. As noted, the first test is the break date for all coefficients, the second for a break in the constant, or intercept. BP_1 and BP_2 refer to the best break dates for the Bai-Perron test, which allows for multiple breaks. The data is quarterly and runs from 1973:4 through 2011:1.

As displayed, the AP test yields significant breaks in two of fourteen possible cases, with a break in the overall set of coefficients for Northern Ireland at 2003:4, and a break for the national UK index in 1985:1. In examining Table 2, it appears that virtually all the UK regions, as well as the overall index, have gone through peak and trough experiences in roughly three different periods - the late 1970s/early 1980s, the late 1980s/early 1990s, and the mid to late 2000s. Given that the UK regional house price indices appear to exhibit three major swings over the sample period, we display the results of the Bai-Perron tests, which allow for three breaks, in the three right columns of Table 2.

In examining the combination of both the Andrews-Ploberger and Bai-Perron breaks, we note that of the forty-four breaks found, only eleven occurred in the 2000s decade. In contrast, there were twenty - four breaks that occurred in the mid-to-late 1980s and early 1990s. In addition, the breaks found for the UK national index are in the late 1970s, late 1980s and early 1990s. These results are highly suggestive that, while the run-up in house prices over the most recent decade was certainly dramatic, and may have reflected the influence of a bubble, the greatest bubble-and-bust episode for UK housing was in the late 1980s and early 1990s.

In Table 3, we display the overall highest (Peak) and lowest (Trough) returns for the regions and the UK index. The biggest boom and bust episode in East Anglia occurred in the late 1980s and early 1990s. As displayed, the peak return for this region is in 1988:3, and the lowest in 1990:3. Both of these dates also correspond to the first and second Bai-Perron break dates. Similarly, the East Midlands had its peak return in the first quarter of 1989 (close to its first Bai-Perron break at 1988:1) and its trough in 1990:4. There was also a local trough in the first quarter of 2009. The city of London had its peak in 1979, but also a smaller peak in 1987 followed by its lowest trough in 1990:4. The city's first two Bai-Perron breaks were in the late 1980s/early 1990s, with a third in 2007. Similar to other regions, the Bai-Perron breaks occurred in 1987:3, 1990:4 (late 1980s/early 1990s) and 2007:4.

The highest peak for the North region occurred in 1989:2, which is just two quarters before the first Bai-Perron break, while the lowest trough was in 2009:1. Northern Ireland is an outlier relative to the other regions, as the area missed any volatile movements over the late 1980s. The region had its peak in 2007:1, and a quick change to a deep trough in 2008:4.

North West had a peak in 1989:3, and a trough in 2009:1. The outer metro region had roughly equal peaks in the late 1970s, 1980s, and 2000s. The highest peak was at 1978:4 (the first Bai-Perron break was at 1979:4) and the most dramatic trough was at 1990:4, which corresponds to the second Bai - Perron break, and there was a trough nearly as large in 2009:4. The outer southeast region reached its highest returns in 1988:4, and a trough in 1990:3. Table 3 shows that although Scotland went through an exceptionally large boom and bust cycle in the 1980s, it had the largest peak at 2004:2, and the most negative price change occurred at 2009:1.

Table 3 Highest and Lowest Returns

	Peak	Trough
East Anglia	1988:3	1990:3
East Midlands	1989:1	1990:4
London	1979:2	1990:4
Northern Ireland	2007:1	2008:4
North	1989:2	2009:1
Northwest	1989:3	2009:1
Outer Metro	1978:4	1990:4
Outer Southeast	1988:4	1990:3
Scotland	2004:2	2009:1
Southwest	1988:4	2008:4
Wales	1989:2	2009:1
West Midlands	1976:1	2009:1
York. & Humb.	1989:1	1990:4
UK	1989:1	2009:1

Note: The Peak and Trough columns refer to the quarters in which each region experienced its highest and lowest returns, respectively.

The South West region, as displayed in Table 3, experienced its biggest peak at the fourth quarter of 1988 (one year after the first Bai-Perron break) while the biggest trough was at 2008:4. Similarly, Wales had a peak at 1989:2 (coinciding with its second Bai-Perron break) and a trough in 2009:1. The West Midlands has its trough in the first quarter of 1976, which was followed by a sharp rise in returns (the first Bai-Perron break was at 1978:1), and had its peak at 1988:1. Similarly, for Yorkshire and Humberside, the peak return was in 1989:1, (this was preceded by a sharp run -up in returns and the first Bai-Perron break a year earlier), a trough in 1990:4, (coinciding with the second Bai-Perron break date) and a smaller trough at 2009:1. The UK national index also went through a peak at 1989:1, a local trough at 1990:4, and the largest trough at 2009:1. Thus the overall picture that emerges from these results is that the 1980s were a larger bubble episode than the 2000s.

Finally, another way to examine the 2000s episode in comparison with the late 1980s and early 1990s is to examine both booms and busts in terms of peak - to-trough returns; indeed, an examination of the data indicates that all of the regions (with the exception of Northern Ireland) went through three major boom and bust events. As noted in Table 3, most regions experienced "global" peaks in the 1980s, but the regions, as well as the UK as a whole, also had "local" maximum and minimum returns over two other periods - the late 1970s/early 1980s, and of course, the 2000s decade.

One measure of the size of a boom and bust episode is the difference between the highest return at the peak versus the lowest return in the bust. Accordingly, in Table 4**,** we calculate the peak-to-trough change for the three episodes for each of the regions as well as the UK national index. As displayed, Table 4 denotes the dates for each "local" maximum and minimum return for the late 1970s/early 1980s (Peak1 and Trough1), late 1980s/early 1990s (Peak2 and Trough2) and the 2000s (Peak3 and Trough3), the exception being Northern Ireland, which had no discernibly large or small returns during the late 1980s. The columns labeled "Δ" show the difference between the (always positive) return in the peak quarter and the (always negative) return in the trough quarter.

For the first episode, all of the regions experienced peaks between 1978:1 and 1979:2 - indeed all but Northern Ireland had peaks between 1978:3 and 1979:2, thus highlighting the common nature of the boom. All of them experienced troughs between 1980:4 and 1982:1. In the late 1980s, all of the regions experienced a peak between 1987:2 and 1989:2, while all of them experienced a trough between 1990:3 and 1992:4. Finally, over the 2000s decade, all of the regions but Northern Ireland had peaks between 2000:1 and 2004:2, and troughs - very closely clustered - in either 2008:4 or 2009:1 (Northern Ireland had its peak in 2007:1).

Table 4 Boom - Bust Episodes

	Peak1	Trough1	Δ	Peak2	Trough2	Δ	Peak3	Trough3	Δ
East Anglia	1979:2	1982:1	0.306	1988:3	1990:4	0.583	2002:4	2009:1	0.492
East Midlands	1979:2	1982:1	0.265	1989:1	1990:4	0.604	2003:1	2009:1	0.474
London	1979:2	1980:4	0.354	1987:2	1990:4	0.49	2000:1	2009:1	0.45
Northern Ireland	1978:1	1981:2	0.329				2007:1	2008:4	0.884
North	1978:4	1981:2	0.199	1989:2	1992:4	0.441	2003:1	2009:1	0.484
Northwest	1979:2	1981:4	0.29	1989:3	1992:1	0.43	2004:2	2009:1	0.44
Outer Metro	1978:4	1982:1	0.321	1987:3	1990:4	0.461	2003:1	2009:1	0.419
Outer Southeast	1979:2	1982:1	0.299	1988:4	1990:3	0.519	2003:1	2009:1	0.484
Scotland	1978:4	1980:4	0.193	1989:3	1990:4	0.308	2004:2	2009:1	0.368
Southwest	1979:2	1981:4	0.288	1988:4	1990:4	0.508	2002:4	2008:4	0.454
Wales	1979:2	1981:4	0.31	1989:2	1990:4	0.553	2004:1	2009:1	0.528
West Midlands	1978:4	1982:1	0.292	1988:4	1991:1	0.49	2003:1	2009:1	0.437
York. & Humb.	1978:3	1981:4	0.196	1989:1	1990:3	0.623	2002:4	2009:1	0.492
UK	1979:2	1981:4	0.273	1989:1	1990:4	0.417	2003:1	2009:1	0.425

Note: The Δ *symbol* refers to the change in returns from the local peak to the local trough.

In examining the size of the difference between peak and trough returns, Table 4 indicates that the late 1970s/early 1980s episode was the smallest of the three events for all regions and the UK as a whole. The late 2000s boom-bust was larger - but only very slightly larger than the 1980s/early 1990s returns change for the UK as a whole, and for the North, Northwest and Scotland (although there was no 1980s episode for comparison, the change for Northern Ireland, was as displayed, very large - indeed larger than any other episode for any region). However, the late 1980s/early 1990s swing in returns was larger than that of the 2000s for nine of the thirteen regions. Moreover, the episode of the late 1980s took place between 1989:1 and 1990:4 for the UK index, while the 2000s episode took a full six years. This makes the change in returns overall in the late 1980s much more sudden than in the 2000s. In addition, the outlier status of Northern Ireland doubtless contributed to the magnitude of the 2000s change in returns. Taken as whole, the late 1980s does seem to be the more jarring episode.

These results do seem sensible, given the large economic changes over the 1980s, especially when contrasted to the greater stability of the more recent decades. In the 1980s, there were several important policy changes that roiled UK housing markets. Baddeley (2005) points out that the 1980s were a time of much deregulation in British housing. Prior to the 1980s, the author points to mortgage rationing, with mortgages typically provided by building societies. However, beginning in the 1980s, "a wide range of other financial institutions were allowed into the mortgage lending market" (Baddeley 2005, p. 5). Mortgage terms "became more flexible and generous (including 100% mortgages)" (Baddeley 2005, p. 5). These changes were followed by a noted increase in homeownership - as well as a sharp rise in mortgage debt in the UK. The author goes on to point out that many borrowers had adjustable-rate mortgages, and a hard time repaying when interest rates rose, which led to a sharp increase in repossessions once the rates rose and recession hit in the early 1990s. Another important change for the housing market occurred in 1988, when it was announced that the double mortgage tax relief would be abolished. According to Cameron et al. (2006), this set off a spike in purchases before the double tax relief was ended.

In addition, the Bank of England (BOE) monetary policy was much more volatile over the late 1980s than the subsequent versions. The BOE rate dropped from about thirteen percent in March 1985 to less than eight percent in May 1988 - likely with a positive effect on house prices and returns. The BOE then nearly doubled the bank rate to almost fifteen percent in just a year-and-a-half. These interest rate changes reflected broader and relatively volatile changes in the BOE behavior. The BOE had a money supply target in the 1980s - it had been missed/overshot - in the high inflation of the 1970s. These overshoots were allowed because of concerns over the recession (Cobham, 2002).

This prompted the Thatcher government to adopt a budget in 1981 which took account of such overshoots. However, these money supply targets continued to be overshot. Thus in March 1987, the money supply targets were abandoned and the BOE adopted an informal exchange rate target by "shadowing" the Deutschmark. The BOE went further and adopted a formal exchange rate target by joining the Exchange Rate Mechanism (ERM) in 1990. While most countries that joined the ERM would go on to adopt the Euro, the UK left the ERM in 1992 during the notorious ERM crisis of that year.

These changes, which included the adopting and not long after, the abandoning of certain targets and policies, appear to have had some negative effects. Miles and Vijverberg (2011) find that joining the ERM, which was meant to inspire confidence, actually raised their measure of uncertainty which concerned the future path of inflation.

In contrast, since the early 1990s, changes in interest rates have become much more stable, save for the drop over 2008 - 2009 in response to the financial and economic crisis. The BOE seemed to pursue a more stable set of policies over these years. The formal inflation target has been maintained for over twenty years (the target has been missed, but the formal target is still retained). In addition, the BOE was given formal independence in 1997. It is of course not clear whether the greater volatility in policy prior to 1992 is responsible for the larger prevalence of breaks in home prices during those years, but clearly, it does not appear to hurt matters that BOE policy has been more predictable.

In addition, the results presented in Table 2 are broadly consistent with prior research. Cameron et al. (2006), by using a different methodology, find no evidence of a bubble during the 2000s (although their sample ended in 2003, at the same time, we find no breaks subsequent to 2003 outside of Northern Ireland). They could not, however, reject the notion of a bubble in the late 1980s. Again, none of this should be taken to mean, of course, that the past decade witnessed no bubbles in UK housing, only that given the dramatic changes in the housing, fiscal and monetary policy in the 1980s, the bubble and bust episode twenty years earlier was more dramatic.

5. Conclusion

The last twenty-five years have seen much volatility in UK house prices across the different regions of the nation. Clements and Hendry (1998) note that periods of turbulence can be associated with parameter changes in times series models and lead to poor prediction. Indeed, the authors state that parameter change "can take many forms, and is probably the main cause of serious forecasting errors when models are used operationally" (p. 168). Obviously, such parameter change makes portfolio management difficult.

The results from applying proper structural break techniques (as opposed to Chow tests on dates chosen by the researcher) indicate parameter change in the UK and its regions. Across the different regions, there is some variation in break dates. This suggests some degree of segmentation in the UK housing market, which has been found by other researchers (see, for example, Holmes and Grimes, 2008). At the same time, the breaks for most regions were clustered in time, with almost all occurring in the late decades of the 1980s or 2000s.

While there were large price swings over the most recent decade, far more breaks correspond to the notorious late 1980s/early 1990s boom and bust episode. This does not, of course, imply that home values in the 2000s had not reached bubble heights. It does suggest, however, that twenty years earlier, home prices became more unmoored from fundamentals than ever subsequently after that.

References

Agnello, L. and Schuknecht L. (2011) Booms and Busts in Housing Markets: Determinants and Implications, *Journal of Housing Economics*, 20, 3, 171 - 190.

Alexander, C. and Barrow M. (1994) Seasonality and Cointegration of Regional House Prices in the UK, *Urban Studies*, 31, 10, 1667 - 1889.

Andrew, M. and Meen G. (2003) House Price Appreciation, Transactions and Structural Change in the British Housing Market: A Macroeconomic Perspective, *Real Estate Economics,* 31, 1, 99 - 116.

Alogoskoufis, G., and Smith R. (1991) The Phillips Curve, the Persistence of Inflation, and the Lucas Critique: Evidence from Exchange Rate Regimes, *American Economic Review,* 81, 5, 1254 - 1275.

Andrews, D. (1993) Tests for Parameter Instability and Structural Change With Unknown Change Point *Econometrica,* 61, 4, 821 - 856.

Andrews, D. and Ploberger W. (1994) Optimal Tests When a Nuisance Parameter is Present Only Under the Alternative, *Econometrica*, 62, 6, 1383 - 1414.

Baddeley, M. (2005) Housing Bubbles, Herds and Frenzies; Evidence from British Housing Markets, *CEPP Policy Brief No. 02/05*.

Bai, J. and Perron P. (2003) Computation and Analysis of Multiple Structural Change Models. *Journal of Applied Econometrics*, 18, 1, 1 - 22.

Barrell, R., Kirby, S. and Riley, R. (2004), The Current Position of UK House Prices, *National Institute Economic Review*, 189, 1, 57 - 60.

Burdekin, R. and Siklos P. (1999) Exchange Rate Regimes and Inflation Persistence: Does Nothing Else Matter?, *Journal of Money, Credit and Banking,* 31, 2, 235 - 247.

Cameron, G., Muellbauer J. and Murphy A. (2006) Was There a British House Price Bubble? Evidence from a Regional Panel, *CEPR Discussion Paper 5619.*

Canarella, G., Miller S. and Pollard S. (2010) Unit Roots and Structural Change: An Application to U.S. House Prices, *University of Connecticut Working Paper No. 2010 - R04.*

Case, K. and Shiller R. (2003) Is There a Bubble in the Housing Market?, *Brookings Papers on Economic Activity,* 34, 2, 299 - 362.

Cecchetti, S. and Debelle G. (2006) Has the Inflation Process Changed? *Economic Policy: A European Forum,* 312 - 352.

Clements, M. and D. Hendry (1998) Forecasting Economic Time Series, Cambridge, Cambridge University Press.

Cobham, D. (2002) The Making of Monetary Policy in the UK 1975 - 2000, John Wiley and Sons, Sussex, England.

Cook, S. (2003) The Convergence of Regional House Prices in the UK, *Urban Studies,* 40, 11, 2285 - 2294.

Cook, S. (2005) Detecting Long - Run Relationships in Regional House Prices in the UK, *International Review of Applied Economics*, 19, 1, 107 - 118.

Cook, S. (2006) A Disaggregated Analysis of Asymmetrical Behavior in the UK Housing Market, *Urban Studies*, 43, 11, 2067 - 2077.

Cook, S. and Thomas C. (2003) An Alternative Approach to Examining the Ripple Effect in UK House Prices, *Applied Economics Letters,* 10, 13, 849 - 851.

Engle, R. (1982) Autoregressive Conditional Heteroscedasticity With Estimates of the Variance of UK Inflation, *Econometrica,* 50, 4, 987 - 1008.

Eksi, O. (2009) Structural Break Estimation: A Survey, *Universitat Pompeu Working Paper.*

Hansen, B. (1992) Testing for Parameter Instability in Linear Models, *Journal of Policy Modeling*, 14, 4, 517 - 533.

Holmes, M. and Grimes A. (2008) Is There Long - Run Convergence of Regional House Prices in the UK?, *Urban Studies,* 45, 8, 1531 - 1544.

Lee, J. and Strazicich, M. (2003) Minimum Lagrange Multiplier Unit Root Test with Two Structural Breaks, *Review of Economics and Statistics,* 85, 4, 1082 - 1089.

Miles, W. (2011) Clustering in UK Home Price Volatility, *Journal of Housing Research,* 20, 1,88 - 101.

Miles, W. and Vijverberg C. (2011) Formal Targets, Central Bank Independence and Inflation Dynamics in the UK: A Markov Switching Approach, *Journal of Macroeconomics,* 33, 4, 644 - 655.

Muellbauer, J. and Murphy A. (1997) Booms and Busts in the UK Housing Market *The Economic Journal,* 107, 445, 1701 - 1727.

Nickell, S. (2005) Practical Issues in UK Monetary Policy, *Keynes Lecture in Economics,* British Academy.

OECD (2005) Recent House Price Developments, *OECD Economic Outlook*, 78, 193 - 234.

Pain, N. and Westaway P. (1997) Modelling Structural Change in the UK Housing market: A Comparison of Alternative House Price Models", *Economic Modelling*, 14, 587 - 610.

Quandt, R. (1960) Tests of the Hypothesis that a Linear Regression Obeys Two Regimes, *Journal of the American Statistical Association,* 55, 290, 324 - 330.

Smith, D. (2008) Testing for Structural Breaks in GARCH Models, *Applied Financial Economics,* 18, 845 - 862.

Taylor, J. (2007) Housing and Monetary Policy, *Kansas City Federal Reserve Bank Symposium.*

Wheaton, W. and Nechayev G. (2008) The 1998 - 2005 Housing "Bubble" and the Current "Correction": What's Different This Time?, *Journal of Real Estate Research,* 30, 1, 1 - 26.

Zhou, W. and D. Sornette (2003) 2000 - 2003 Real Estate Bubble in the UK but not in the USA, *Physica A,* 329, 1, 249 - 263.