Asset prices regime-switching and the role of inflation targeting monetary policy.

Ioannis Chatziantoniou[a,*], George Filis[b], Christos Floros[c]

[a]*University of Portsmouth, Subject Group of Economics and Finance, Portsmouth Business School, Portland Street, PO1 3DE, United Kingdom.*

[b]*Bournemouth University, Accounting, Finance and Economics Department, 89 Holdenhurst Road, Bournemouth, Dorset, BH8 8EB, United Kingdom.*

[c]*Technological Educational Institute of Crete, Department of Accounting and Finance, GR71004, P.O. Box 1939, Crete, Greece and Hellenic Open University.*

* Corresponding author: e-mail: ioannis.chatziantoniou@port.ac.uk, tel:+44 (0) 2392 84 4022, fax: +44 (0) 2392 84 4037.

Abstract

This paper provides the empirical framework to assess whether UK monetary policy shocks induce both the UK housing market and the UK stock market to remain at a high-volatility (risk) environment. The Markov regime switching modelling approach is employed in order to identify two distinct environments for each market; namely, a high-risk environment and a low-risk environment, while a probit model is employed in order to test whether monetary policy shocks provide this predictive information regarding the current state of both markets under consideration. Our findings indicate that monetary policy shocks do indeed have predictive power on the stock market. In addition, in both asset markets there is a key role for inflation. Results are important especially within the framework of the inflation targeting monetary policy regime.

Keywords: United Kingdom, Inflation targeting, Markov regime switching, Forecasting, Asset prices

JEL codes: C22; E52; G1

1. Introduction

This study investigates the effects of UK monetary policy on the UK housing and the UK stock market respectively, considering two distinct regimes/states for each market; namely, a high-risk environment and a low-risk environment. In particular, the main objective is to investigate whether UK monetary policy decision making induces these markets to remain at the high-risk environment at times of economic turbulence. In this regard, the underlying hypothesis of the study is that developments in UK monetary policy may have predictive power on both UK markets of interest. Once this is established, the findings of the study can then be used to inform monetary policy decisions.

To accomplish our objective, initially, we consider a two-state Markov process, in order to draw a distinction between the high-risk environment and the low-risk environment for both the UK housing and the UK stock market. It should be noted that the classification of these regimes is based on each regime's degree of volatility as the latter is measured by the corresponding standard deviation. Having established the two differing regimes, we then turn to a probit regression framework, to test whether a monetary policy shock, approximated by positive changes in the short term interest rate of the economy, has any effect on the probability that both markets move across these two distinct regimes. It is also worth noting that the analysis emphasizes periods characterised by turbulent economic conditions, as well as, monetary policy conduct characterised by upward adjustments of interest rates (i.e. contractionary policy).

Considering the framework of the study, this mainly comprises two parts. The first part is related to the fact that monetary policy at the Bank of England (BoE) is inflation targeting and therefore is dedicated to promoting increased levels of transparency and to effectively controlling expectations regarding the future level of inflation in the economy. Existing literature on inflation targeting suggests that given increased levels of monetary policy credibility, economic agents and – by implication – asset markets, fashion their expectations on the basis of broader economic conditions and concentrate less on changes in the monetary policy instrument (see, *inter alia*, Sims, 2003; Lomax, 2004; as well as, King, 2012). This could be suggestive of the fact that rises in the short term interest rate of the economy may even have a positive impact on asset prices if economic agents perceive this as the consistent effort on behalf of the central bank to successfully control inflationary pressures. This suggestion deviates considerably from the traditional view – albeit this mainly concerns the stock market, which has been extensively investigated by existing literature – that there exists a negative relationship between interest rates and asset prices (see, among others, Mishkin, 2001; and Bjornland and Leitemo, 2009).

The second part of the framework is provided by the link between monetary and fiscal policies. In particular, authors such as Pastor and Veronesi (2012) opine that stock markets can be extremely alert when it comes to changes in Government policy, as typically the latter involves fundamental changes in the economic environment. What is more, Baker *et al.* (2013) report that increased levels of economic uncertainty exert negative effects on investment. It follows that increased levels of monetary policy transparency and credibility might be offset by increased levels of uncertainty.

Weaving together the pieces of information provided above, we proceed with the investigation of whether rises in the monetary policy instrument – at times of economic turmoil – induce any of the two markets of interest to remain at the high-risk environment. It follows that the intended outcomes of the study are mainly related to the fact that during periods of increased economic unrest monetary policy should affect asset markets even under an inflation targeting monetary policy stance.

The period of study is January 1992 to November 2014. The United Kingdom was chosen mainly for the reason that BoE has adopted an explicit inflation target since October 1992 when the UK decided to leave the European Exchange Rate Mechanism (ERM). Furthermore, the fact alone that housing and financial prices are at the heart of this study, stresses the necessity to focus on a country whose relevant markets are both dynamic and influential, and therefore, of particular interest to policy and decision makers. The UK economy exhibits these features at large, and further provides fertile ground for this kind of analysis in many respects, as in recent years, it has witnessed not only significant increases in housing prices (Bean, 2003a; ONS, 2013a), but also, substantial financial turmoil related to drastic developments in financial markets - both domestically and at the international level (Schwert, 2011). Therefore, shedding light on the linkages between monetary policy decision making and the two markets of interest could improve our understanding regarding developments in the UK economy.

Prominent among the results of the study is that monetary policy shocks do provide predictive information regarding the state of the stock market, while results for the housing market are rather inconclusive. What is more, inflation appears to have a very important role to play in both markets, as apparently, higher levels of inflation induce both markets to remain at the high-volatility regime. Findings are non-trivial especially when it comes to investigating the consequences of inflation targeting monetary strategy with which central banks specifically aim at anchoring expectations about future inflation. Predicated upon higher levels of transparency and accountability on behalf of the monetary policy authority, inflation targeting is assumed to lead to better macroeconomic and financial results (see, *inter alia*, King, 2012). However, the findings of this study suggest that at times of economic distress the effects of monetary policy decisions on the economy may be somewhat different than expected.

The remainder of this paper is structured as follows: Section 2 presents an account of the existing related literature. A detailed description both of the employed time series and the adopted methods is subsequently presented in Section 3. Then, in Section 4, follows an overview, as well as, a thorough discussion of the relevant findings. Finally, Section 5 concludes the study.

2. Review of the literature

2.1 The UK housing market and the role of monetary policy.

According to Mishkin (2001), there are three main channels through which the employed monetary policy instrument can affect the economy via housing prices; that is, via direct effects on housing investment (*e.g.* higher interest rates render borrowing more expensive and thus reduce demand for housing and housing prices), via wealth effects (*e.g.* higher interest rates imply costlier access to money and thus reduce households' consumption and investment), as well as, via bank balance sheets (*e.g.* higher interest rates imply lower demand for housing and thus lower housing prices and in turn, households can borrow less using the value of their home as collateral). In addition, authors such as Dvornak and Kohler (2007), Iacoviello and Neri (2007), as well as, Sousa (2010) report that housing prices fluctuations in recent years can be attributed to a great extend to monetary policy decisions. What is more, Carstensen *et al.* (2009) support the idea that collateral constraints along with the terms of credit generally magnify the impact of monetary policy on the economy. In this regard, existing literature is in favour of the argument that there is a close link between monetary policy decision making and the housing market.

With reference to recent developments specifically in the UK housing market, almost throughout the period that began after the crisis of the early 1990s and ended with the outburst of the Great Recession in the third quarter of 2007, housing prices rose at a rate faster than the rate of inflation (see, *inter alia*, Bone and O'Reilly, 2010; ONS, 2013a). Reinold (2011) points out that the credit crunch of 2007 resulted in lower housing prices, tighter lending conditions, as well as, less availability of credit; a combination of events which subsequently led to an overall decline in housing market transactions.

As far as the pre-2007 period is concerned, Cobham (2013) reports that early on in 2002 the Monetary Policy Committee (MPC) had attributed rising housing prices to a number of reasons such as: the relative price stability of the period mainly due to a relatively successful inflation targeting monetary policy, the potential reallocation of investment from equity markets to the housing market, competition among commercial banks leading to ever lower nominal interest rates, as well as, to a further slowdown in construction output (due to legal complexities or time-consuming planning permission processes). The latter (*i.e.,* the relative shortage in the supply of dwellings) has also been reported by authors such as Bean (2003), Barker (2004), Reinold (2011), Whitehead and Williams (2011), as well as, Poon and Garratt (2012). Supply of housing appears to be insufficient compared to a strong demand for new houses supported by accelerating migration, easy access to credit, as well as, accommodative monetary policies (Whitehead and Williams, 2011). The low interest rates of that period and loose credit have also been emphasized by authors such as Bekaert *et al.* (2007), Hay (2009), as well as, Bone and O'Reilly (2010).

In the third quarter of 2007 UK housing prices plunged by about 19% in nominal terms; however, starting from the first quarter of 2009 the was an upturn in the UK housing market which was mainly driven (i) by the introduction of two housing demand-stimulus schemes[1] and (ii) by the rather inelastic housing supply (Chandler and Disney, 2014). According to ONS (2013b) construction output in the first quarter of 2013 still remained at its lowest level

[1] "Help to buy: equity loan" and "Help to buy: mortgage guarantee" schemes.

since 1998. Worth noting that authors such as Bean (2003) and Pan *et al.* (2007) among others, argue that the persistent low housing supply in the UK might sometimes lead to counter-intuitive economic results (i.e. the existence of high prices despite weak demand).

The view that housing prices switch between regimes of different degrees of volatility has been suggested by authors such as Hall *et al.* (1997) and Tsai *et al.* (2010). More specifically, Hall *et al.* (1997) argued that highly volatile and unstable regimes could provide fertile ground for the development of bubbles in the UK housing market. What is more, the importance of interest rates for housing prices movements has been argued by many authors, including Lastrapes (2002), Iacoviello and Minetti (2003), as well as, McQuinn and O'Reilly (2008). Most of these authors concentrate on the positive impact on housing prices that typically follows the adoption of low interest rates. Himmelberg *et al.* (2003) further maintain that housing markets characterised by relative inelastic supply, tend to be much more influenced by changes in interest rates than others. On a final note, Nneji *et al.* (2013) who conduct a similar study for the US housing market, put forward the argument that - as far as housing markets are concerned – existing literature has rather neglected the investigation of their cyclicality.

2.2 The UK stock market and the role monetary policy.

In the work of Mishkin (2001) we find four channels through which changes in the policy instrument can affect the economy via the stock market. In particular, Mishkin (2001) suggests that monetary policy can affect the stock market via direct effects on investment (*e.g.* Tobin's q theory according to which, potential rises in the interest rates of the economy would discourage investors from buying shares, causing stock prices to fall and firms to invest less in new equipment), via effect's on businesses balance sheets (*e.g.* when the price of a company's stock is directly linked with its ability to borrow money from the money market), via wealth effects (*e.g.* higher interest rates reduce stock prices and therefore investors tend to consume less either because they will not sell their shares and capitalise their gains or because they just do not feel wealthier at the new low level of prices), as well as, via liquidity effects (*e.g.* in principle – mainly due to asymmetric information regarding the quality of most consumer durable products and housing – economic agents would rather cling on to relatively more liquid investments such as shares of stocks. In this regard, economic agents feel that they are better secured against potential liquidity problems. However, when stock prices rise, due – for example – to lower interest rates in the economy, the chances that any household will enter a period of financial distress are rather low, implying that the household might also choose to consume more of the relatively less liquid consumer durable products).

On general principles, the relation between interest rates and the stock market is regarded as a negative one (see, inter alia, King and Watson, 1996; Lastrapes, 2002; Bjornland and Leitemo, 2009; Castelnuovo and Nistico, 2010). Nonetheless, according to the inflation targeting monetary policy literature (see, *inter alia*, Sims, 2003; Lomax, 2004; King, 2012) this may not be entirely true when the monetary policy authority prioritises the control of inflation and thus economic agents relegate interest rate decisions to a secondary level.

As far as the UK capital market is concerned, general indices such as the FTSE-all share index have followed the trend of broader economic developments reflecting – to a great extent – the economic slowdown of the UK economy that began in the third quarter of 2007, as well as, the efforts for recovery thereafter. It is worth noting that the UK capital market suffered significant losses during the period 2008-2009 and only started picking up in the second quarter of 2009. Authors like Arestis and Karakitsos (2009), Hay (2009), Blanchard et al. (2010), Stiglitz (2010), as well as, Whitehead and Williams (2011) among others, advocate that spillovers of the U.S. subprime crisis towards the economies of Eastern Europe along with huge injections of liquidity (in the form of easily approved loans) have – to a great extent – been responsible for the development of various asset bubbles (including bubbles in international housing and financial markets which in turn gave way to the global economic meltdown that followed).

According to ONS (2012), the UK stock market maintains an upward trend throughout the years; however, since 1995 it has become much more volatile. As reported by ONS (2012) the first sharp rise for the UK stock market was in the period between 1996 and 1999; that is, during the dot-com bubble. Immediately after the burst of this bubble, the main stock market indices collapsed by almost 50% in between 2000 and 2003. From then onwards, the UK stock market regained momentum until the years of the *Great Recession* and the credit crunch that followed the 2007 subprime mortgage crisis in the United States. During the years of the crisis the main indices fell by around 40% before returning to the path of growth (ONS, 2012). As far as more recent developments are concerned, according to BoE (2013) equity prices maintain an upward trend since June 2012 and this mainly reflects the willingness of investors to hold riskier assets.

The idea that stock markets move between two alternative states is not quite new. Authors such as Turner et al. (1989), Schaller and Norden (1997), Maheu and McCurdy (2000), Guidolin and Timmermann (2005), Ismail and Isa (2008), as well as, Chen (2010) provide evidence to suggest the existence of two regimes for the stock markets; namely, a bullish (i.e. low-volatility and high returns) regime and a bearish (i.e. high-volatility and low returns) regime. Furthermore, Thorbecke (1997), Mishkin (2001), as well as, Rigobon and Sack (2003), among others, put forward the argument that contractionary monetary policy could potentially lead to lower stock market returns. However, as explicitly mentioned in Sims (2003) and Bernanke and Kuttner (2005) we should be very careful in deciphering the potential impact of monetary policy decisions on the stock market because the latter is rather unlikely to respond to already anticipated policy decisions (*i.e.* inflation targeting strategy).

In the section that follows we outline the data and the specific methods employed by this study in order not only to successfully identify the relevant regimes for each one of the two markets under investigation, but also, to test the hypothesis that developments in the BoE may have predictive power regarding both of these markets.

3. Data and the econometric method

Monetary policy decision making is approximated by a short term interest rate of the UK economy; that is, the interbank rate. In order to isolate the pure effect deriving from monetary policy decision making, we further employ a number of additional series which act as control variables. These series include the CPI-inflation, as well as, housing prices and financial prices which are approximated by the Halifax housing prices index and the FTSE all-share index, respectively.

We employ monthly data for the period between January 1992 and November 2014 that are seasonally adjusted and expressed in logarithmic differences. Furthermore, all variables of interest are constant in 2005 prices. All data have been extracted from Thomson Reuters Datastream. Figure 1 summarises the aforementioned series (in levels).

[INSERT FIGURE 1 HERE]

The first step is the identification of the relevant alternative regimes for both types of assets. The starting point at this stage of analysis is that there exists a relatively fundamental two-state Markov process which can sufficiently describe the workings of real economic activity in both individual markets.

It would be important to note at this point that although deciding upon the number of regimes can be dictated by the framework of the study (in our study the distinction between high-risk and low-risk environment for either the stock or the housing market appears to qualify a two-state framework); statistical tests have also been developed in order to determine the number of regimes directly from the data (see, *inter alia*, Ang and Bekaert, 1998; Garcia, 1998; Laurini and Portugal, 2004; Ang and Timmermann, 2011). It is worth noting that Ang and Timmermann (2011) opine that the decision regarding the appropriate number of regimes should not be based on econometric tests; especially as in most cases these tests do not follow standard distributions.

One of these statistical approaches is the log-likelihood ratio (LR) test. The results we obtain from this test[2] verify that describing both markets using two regimes is better than describing the markets using just one single state. What is more, we refrain from having a different number of potential regimes for each market and we maintain that two states are indeed sufficient. To be more explicit, we put forward the argument that the inclusion of both markets in this study provides fertile ground for making direct comparisons between them, and thus maintaining one single framework for both could facilitate achieving this tributary objective. In this regard, we proceed with our analysis attempting a two-state description of both markets.

Following Chen (2007) and Kurov (2010) we employ a simple mean-variance autoregressive Markov regime switching model of order zero [MS-AR(0)] for both markets. On the basis that we have 2 potential states (i.e. $s_t = 1$ corresponding to the low-risk environment and $s_t = 2$, corresponding to the high-risk environment), the basic regime switching model can be written as in Perlin (2012):

---

[2] Results are available upon request.

$$y_t = \mu_1 + \varepsilon_{t,1}, \quad \varepsilon_{t,0} \sim N(0, \sigma_2^2) \tag{1}$$

$$y_t = \mu_2 + \varepsilon_{t,2}, \quad \varepsilon_{t,1} \sim N(0, \sigma_2^2) \quad , \tag{2}$$

where, y_t is the time series under investigation (*i.e.* within the framework of this study, this will be either the financial or the housing prices), μ_1 is the conditional mean of one of the series each time (i.e. either housing or financial prices) under regime (1), μ_2 is the conditional mean of each series under regime (2), σ_1 is the standard deviation under regime (1) and σ_2 is the standard deviation under regime (2). Both variables s_t and the ε_t follow a normal distribution with zero mean and variance equal to σ^2. Note that depending on the value of s_t we get different values for both μ and σ^2. The number of the potential values that both μ and σ^2 can assume is equal to the number of states (N). In this case the number of states is equal to 2.

The structure of the model as given by (1) and (2) implies that the difference between the two regimes is a mean and volatility shift (excluding any autoregressive change). On top of that, it is understood that s_t is a latent variable that can only be observed through the behaviour of y_t and that the regimes have been arbitrarily defined (Hamilton, 2008). According to Hamilton (1989) the transition between the various regimes is a stochastic first-order Markov process which implies that the state at time (t); that is, $s_t = 1, 2$ depends only on the previous state; that is, $s_{t-1} = 1, 2$ (Hamilton, 1989). In other words, s_t depends on certain transition probabilities.

Given that the variable s_t can only be observed through the behaviour of y_t, Hamilton (2008) maintains that in order to appropriately describe the probability law relating to y_t we have to calculate all the necessary parameters for both regimes, which in this case include, the average level of the series, the variance of the Gaussian innovation ε_t, as well as, the transition probabilities. In the 2-State case the problem takes the following form:

$$\begin{bmatrix}\pi(s_t = 1)\\ \pi(s_t = 2)\end{bmatrix} = \begin{bmatrix} p_{11} & 1 - p_{22} \\ 1 - p_{11} & p_{22}\end{bmatrix} \times \begin{bmatrix}\pi(s_{t-1} = 1)\\ \pi(s_{t-1} = 2)\end{bmatrix}, \quad (3)$$

where, p_{11} is the transition probability that the system will remain at state 1, $1 - p_{11}$ is the transition probability that the system will move from state 1 to state 2, p_{22} is the transition probability that the system will remain at state 2, $1 - p_{22}$ is the transition probability that the system will move from state 2 to state 1, π_i is the probability that the time series of study y_t currently is at a certain state, and of course, $\sum_{i=1}^{N} p_{ij} = 1$.

As shown by Hamilton (1989) all of the population parameters of the model in (1) and (2) along with the transition probabilities in (3) can be estimated by maximum likelihood approaches and appropriate logarithms[3]. Piger (2009) illustrates that a general form of the log-likelihood function to be maximised in the case of regime switching models could be the following:

$$l(\boldsymbol{\vartheta}) = \sum_{t=1}^{T} l_t(\boldsymbol{\vartheta}), \quad (4)$$

where, $\boldsymbol{\vartheta}$ is a row vector of population parameters:

$$\boldsymbol{\vartheta} = [p_{11}, \quad p_{22}, \quad \mu_1, \quad \mu_2, \quad \sigma_1^2, \quad \sigma_2^2]. \quad (5)$$

Once the results are obtained we can then make specific inferences regarding the transition of the system from one regime to another.

Furthermore, deviating from Hamilton (1989) and yet in line with Chen (2007) and Nneji et al. (2013) we assume a fixed transition probabilities (FTP) setup (*i.e.* $\pi_i s$ are assumed to be fixed), instead of a time-varying (TVTP) one. This basically entails that the transition

[3] Maximum likelihood calculations in our model are based on the feasible sequential quadratic programming (SQPF) algorithm introduced by Lawrence and Tits (2001) which is provided by the Ox-Metrics software.

probabilities matrix remains fixed over time, facilitating the investigation of the actual factors (*i.e.* monetary policy decisions, economic growth etc.) that can predict the state of each market. To put it differently, we investigate the possibility to know beforehand the time and the reason why a regime-shift is likely to occur and not the reason that makes the transition probabilities change over time in general. Furthermore, in both markets, we test for the strength / validity of our regimes-classification by applying Ang and Bekaert's (2002) regime classification measure (RCM). This is given by the following formula:

$$RCM = 400\frac{1}{T}\sum_{t=1}^{T} p_t(1-p_t), \tag{6}$$

where $p_t = p(s_t|\Omega_T)$ and Ω_T is the information set corresponding to the entire sample employed in the models. The RCM assumes values between 0 and 100 and lower values consistently entail successful classification / identification of the corresponding regimes.

Finally, in order to test the ability of our model to make forecasts regarding the future regime of each market a probit model is employed which entails a binary specification for the dependent variable under investigation; that is, for the probability that each one of the markets under investigation will remain at the high volatility regime.

More explicitly, we estimate the following probit regression:

$$P_{(S_t=2)} = F(a + \beta_i R_{t-1} + \boldsymbol{\gamma}_i \boldsymbol{X}_{t-1}), \tag{7}$$

where $S_t = 2$ when the state probability is greater than 50% and $S_t = 1$ otherwise. Regressors include the monetary policy instrument (i.e. the short term interest rate denoted by R_i) and a vector $\boldsymbol{X}_i$ comprising the control variables of the model, namely, the lagged value of the probability itself, housing or financial prices – depending on the specification of the model (i.e. we investigate the effect of the housing market on stock market developments and vice versa) and the inflation rate. We conduct this regression analysis in three steps. First, we regress the said probability against its own lagged value and the lagged value of the interbank rate (*i.e.*, the monetary policy instrument). Then we regress it against the selected control variables. Finally we run the regression employing all explanatory variables in tandem.

4. Empirical results and discussion

4.1 Identifying the underlying regimes.

We begin our analysis by focusing on the financial market. Results are presented in table 1. Our model clearly identifies two distinct regimes; that is, regime 1, which is characterised by positive returns μ_1 and lower volatility σ_1 and regime 2, which is characterised by negative returns μ_2 and high volatility σ_2. It is worth noting that all coefficients are statistically significant and assume the appropriate sign. The RCM value is very low indicating appropriate classification.

[INSERT TABLE 1 HERE]

The corresponding transition probabilities matrix is then given by:

$$\begin{bmatrix} p_{11} & 1-p_{22} \\ 1-p_{11} & p_{22} \end{bmatrix} = \begin{bmatrix} 0.977 & 0.058 \\ 0.023 & 0.942 \end{bmatrix}. \quad (8)$$

Apparently, the probability to stay in each regime is quite high (i.e. 94.2% chance to stay at the high risk regime and 97.7% chance to stay at the low risk regime) implying quite persistent regimes. The chance for the stock market to move from the high risk environment/regime to the low risk environment/regime is approximately 6%; while the probability for the reverse event to occur is just a bit greater than 2%.

In line with Chen (2007) and Nneji et al. (2013) we can use the following formula in order to be more precise regarding the expected duration (ED) of each regime:

$$ED = \frac{1}{(1 - p_{ii})} \ . \tag{9}$$

In this case, the expected duration of regime 1 will be approximately equal to 43.48 months, while the expected duration of regime 2 will be approximately equal to 17.24 months. Roughly speaking, results are suggestive of the fact that we should expect the bullish stock market regime to last longer before a switch is made towards the bearish regime.

As far as the housing market is concerned, results are presented in table 2. In particular, our model clearly identifies two distinct regimes; that is, regime 1, which is characterised by positive returns μ_1 and volatility σ_1, and regime 2, which is characterised by negative returns μ_1 and higher volatility σ_2.

[INSERT TABLE 2 HERE]

The corresponding transition probabilities matrix is given by:

$$\begin{bmatrix} p_{11} & 1 - p_{22} \\ 1 - p_{11} & p_{22} \end{bmatrix} = \begin{bmatrix} 0.986 & 0.033 \\ 0.014 & 0.967 \end{bmatrix} \ . \tag{10}$$

The RCM value as an indication of successful classification of the potential regimes is again quite satisfactory. The coefficient for μ_1 is not statistically significant. As in the previous case, results indicate that we may proceed with our model in order to have a first impression of the regime switching process in this particular market.

Similarly to the stock market case, the probability to stay in each regime is quite high (i.e. 98.6% chance to stay at the low volatility regime and 96.7% chance to stay at the high volatility regime) implying quite persistent regimes. The chance for the housing market to move from the higher volatility regime to the lower volatility regime is approximately 3%;

while the probability for the reverse event to occur is a bit greater than 1%. As far as the expected duration of each regime is concerned, the expected duration of regime 1 will be approximately equal to 71.42 months, while the expected duration of regime 2 will be approximately equal to 30.30 months.

[INSERT FIGURE 2 HERE]

In effect, results suggest that we should expect the relatively more stable regime to last longer than the unstable regime before the switch.

Figure 2 illustrates the smoothed probabilities of the estimated regimes for both markets. In order to construct all four panels in this figure, we follow Chen (2007) and we simply take 0.5 as the cut-off point between the two regimes and when for one of the two alternative regimes (*e.g.* for regime $S_t = 2$) the probability assumes a value less than 0.5 then the stock market – for example – will more likely be a bear market, whereas a value greater than 0.5 for the stock market would imply that the stock market is a bull market. Furthermore, panels (a) and (b) correspond to the stock market while panels (c) and (d) correspond to the housing market. Obviously, panel (a) is the mirror image of panel (b) and panel (c) is the mirror image of panel (d).

In order to investigate the alternative regimes assumed by the markets of interest throughout the period of study and get a more complete picture we also have to consider the changes in both markets. This materialises in Figures 3 and 4. In these figures we have chosen one of the two alternative regimes corresponding to the markets of interest[4] and we have added the path of the percentage changes in both assets prices. The practical use of incorporating growth paths for both housing and financial prices in the relevant regime switching plots is to check whether any dominant state - with reference to the period of study - can be identified.

[4] In particular, for both markets we have chosen the high volatility regime; that is, $S_t = 2$.

Starting with the stock market, we concentrate on Figure 3. Evidently, stock market prices grew at a relatively stable pace until around 1997 when a high volatile regime is indeed verified by our results. On general principles, the period between 1997 and 2003 was quite volatile for the stock markets, as it was marked by the contagious US banking-sector turmoil and the dot-com bubble. Consequently, regime 2; that is, the high volatility regime, was the dominant regime for that period. From then on, the growth path of stock market prices was relatively stable (with only a few exceptions) until the outbreak of the *Great Recession*; that is, the global financial crisis which began in August 2007 in the aftermath of the housing bubble in the United States. This increased volatility in stock market returns is captured by our findings which clearly recognize the dominance of a high volatility regime for a period between late 2007 and late 2009, while it is also obvious that stock market returns go back to a stable path sometime during 2010. It is only then, when regime 1 (*i.e.*, the low volatility regime) becomes the dominant regime in the market. In this regard, and as far as the stock market is concerned, we are satisfied with the empirical findings of our model in terms of the latter adequately describing the probabilities of two distinct states which could help delineate the market and better explain stock market developments.

Turning to the housing market, Figure 4 illustrates the probabilities for the housing market to be in one of the two regimes based on the chart for the high volatility regime. It is evident from Figure 4 that the growth path for housing prices was relatively stable until the peak years of the *Great Recession*. Our empirical findings can verify this by providing a very low (close to zero) probability for the market to be in regime 1 throughout this particular period. The period between late 1990s and 2005 is generally regarded as a period in which housing prices in the UK rose considerably and authors such as Bone and O'Reilly (2010) and Morley and Thomas (2011) raise the question of whether this unprecedented hike in housing prices could be attributed to factors other than just the adoption of an expansionary policy approach, such as, the development of a some speculative bubble in the market. Authors such as Kuenzel and Bjørnbak (2008) and Bone and O'Reilly (2010) put heavy emphasis on the fact that UK housing prices - almost throughout the period that began after the crisis of the early 1990s and ended with the credit crunch in late 2007 - rose at a rate faster than the rate of inflation.

[INSERT FIGURE 3 HERE]

From then onwards, the market remains very volatile, however it is difficult to identify a dominant regime, although the prevalence of regime 2 for the period between 2008 and 2010 is probably the most straightforward case.

It is worth noting, that there is definitely a persistent downward adjustment in housing prices starting in 2005 and holding for almost throughout the peak-years of the crisis, while at times (e.g. the period between January 2010 and January 2011, or the period between July 2011 and July 2012) the housing market growth rate volatility becomes really big. Overall, our findings suggest that the 2-state Markov model performs very well until the very recent years of our analysis.

In relation to downward adjustments in housing prices, authors such as Nneji *et al.* (2013) provide evidence from the US housing market and further opine that apart from everything else, the *Great Recession* has also led to a meltdown in the mortgage market as well. Considering the evidence provided by Nneji *et al.* (2013) we arrive at the conclusion that both the US and the UK housing markets have behaved in a similar way. To be more explicit, it appears that both markets initially experienced a persistent hike during the years immediately before the crisis and then suffered unprecedented shrinking in the years that followed the crisis. One of the main implications deriving from our results is that it may very well be that the volatility of UK housing prices has acquired new features over the past few years; that is, in analysing the volatility of recent years we have to consider the large drops in housing prices between the years 2007 and 2008.

[INSERT FIGURE 4 HERE]

4.2 Forces that bolster high-volatility.

The next step is to test the ability of our model to make forecasts regarding the possibility that each market will remain at a specific regime given changes in the monetary policy instrument, as well as, in other variables. In effect, having established the classification of the divergent regimes in the housing and the financial market, the next step is to identify whether monetary policy decision making affects the probability of each market to be in any of the two alternative regimes.

As earlier mentioned, in order to accomplish this we employ a probit model which entails a binary specification for the dependent variable under investigation. For both markets, this is the probability to remain at the high volatility regime ($S_t = 2$). In both cases, if the probability of staying at the high volatility regime is greater than 0.5 then the dependent variable of the probit model assumes the value of 1. On the other hand, if the probability of being at the high volatility regime is less than 0.5 then the dependent variable of the probit model assumes the value of 0. For each market, the new binary series is constructed by considering all probabilities that correspond to the high volatility regime throughout the period of study. We concentrate on the sign of the relevant coefficients and in order to check the robustness of our results we employ a three-stage analysis (*i.e.*, three distinct regression equations). The outcome of this exercise is very important for monetary policy decision making, as the monetary authority would be rather keen on knowing whether the short-term interest rate instrument could be used in order to induce any of these markets away from a high risk and towards a low risk environment.

Initially, we turn our attention to the stock market. Results are shown in table 3. The positive sign assumed by the coefficient pertaining to the monetary policy instrument in both the 1^{st} and the 3^{rd} regression equation, implies that rises in the short-term interest rate increase the probability that the stock market will remain at the high risk regime. This result accords with Chen (2007). However, the relationship appears to be statistically significant only when we consider all variables together (*i.e.,* in the 3^{rd} regression equation where all control variables have been included). What is more, the lagged value of the probability itself also has a key role to play. In addition, as evidenced in the 2^{nd} and the 3^{rd} regression equation, upward adjustments in both markets induce the stock market away from the high-volatility regime (*i.e.*, the relevant coefficients assume a negative sign). Finally, the coefficient of CPI inflation assumes a positive sign implying that rises in the inflation rate induce the stock market to remain in the high-volatility regime. We can therefore reach two important conclusions regarding the stock market in the UK. First, abrupt increases of the policy instrument do not help remove volatility from the market. Second – given the inflation targeting character of the monetary policy in the UK – successfully anchoring expectations regarding future inflation rates is very important because higher levels of inflation induce the stock market to remain at the high-volatility regime. On a secondary level, given the negative coefficient relating to HALIFAX, we are able to provide some initial evidence regarding the interrelation between the housing and the stock market. To be more explicit, results indicate that higher housing prices help the stock market move away from the high-volatility regime.

[INSERT TABLES 3 AND 4 HERE]

Turning to the housing market, results are given by table 4. Apparently, results are not conclusive regarding the direct influence of the policy instrument on the probability for the housing market to remain at the high-volatility regime. The relevant coefficient assumes a positive sign in the 3rd regression equation; however, this is not statistically significant. This result is in line with the evidence provided by Nneji et al. (2013) – for the US housing market – who also report inconclusive results. On the other hand, the lagged value of the probability appears to play a key role. What is more, rises in both the housing and the stock market prices appear to help the housing market move away from the high-volatility regime (*i.e.*, due to the negative signs assumed by the relevant coefficients). Finally, rises in the rate of inflation induce the market to remain at the high-volatility regime. On the basis of these results we can deduce the following regarding the housing market in the UK. First, it is not clear whether abrupt rises in the monetary policy instrument are related to higher volatility in the housing market. Second, similarly to the stock market, anchoring expectations about future inflation will help move the housing market away from the high-volatility regime. On a secondary level, it should be noted, that upward adjustments in the FTSE lead the housing market away from the high-volatility regime. Thus, again we notice the positive relationship between the two asset markets.

In support of the findings regarding the effects of inflation on both markets, Brunnermeier and Juliard (2008) put forward the argument that rises in inflation could be seen by economic agents as a signal of future downturns implying further turmoil. Within the inflation targeting monetary policy regime, emphasis is put on the control of self-fulfilling expectations regarding the future level of inflation, a fact which by itself is conducive to lower volatility in both markets under investigation. With regard to the stock market, prominent among our results, is also the fact that monetary policy decision making, has a key role to play in determining the dominant regime in the stock market. Apparently, higher short-term interest rates are conducive to further turbulence, and thus the stock market remains constrained within the high volatility regime. These findings suggest that our model has some predictive power and can be used in policy analysis and especially in deciphering the impacts of policy decisions during turbulent times.

4.3 The role of monetary policy decision making.

We have already mentioned that the UK housing market exhibits many unique characteristics (a pronounced lack of supply being its first and foremost) implying that any results concerning the housing market may be quite difficult to interpret. It is a fact though, that housing prices in the UK exhibit high volatility. In particular, Tsatsaronis and Zhu (2004) and Mishkin (2007), put forward the argument that housing prices tend to be more volatile in countries with a high ratio of mortgage loans based on variable rates. In supplement to this, authors such as Miles (2004) and Becker et al. (2012) report that most mortgage loans in the UK have indeed been offered on the basis of some variable rate. One should expect that higher interest rates could be held responsible for fashioning negative expectations regarding the future lending rates in the economy (this is particularly true for mortgage loans structured on the basis of variable interest rates) resulting in economic agents reluctant to acquire a loan and thus leading to a new circle of uncertainty in the housing market where low supply, on one hand, pushes prices upwards and lower demand for properties, on the other hand, pushes prices downwards. In this respect, results from this study are not conclusive and further research is required; however, results regarding the effects of inflation highlight the importance of a resilient monetary policy regime.

In principle, it is expected that the relationship between interest rates and stock market returns is a negative one as higher interest rates are typically associated with increased cost of capital and therefore smaller future cash inflows (see, *inter alia*, Mishkin, 2001; Bjornland and Leitemo, 2009). Nonetheless, in dealing with an inflation targeting monetary policy regime, authors such as Sims (2003), Lomax (2004), as well as, King (2012) argue that monetary policy decision making could sometimes entail unconventional results for the stock market as within an inflation targeting regime it is the actual and the expected levels of inflation that matter the most for economic developments; implying that issues relating to interest rate and money growth changes are relegated to a secondary level. In this regard, any rises in the level of interest rates could even be perceived as a positive signal from market participants in the sense that the monetary policy authority is consistently responding to its main task which is to successfully control inflation in the economy. According to Bomfim (2003), removing the element of surprise from the monetary policy decision making process, greatly affects the results we obtain regarding the impact of monetary policy in the volatility observed in the stock market. In testament to this, Li et al. (2010) in analysing the effects of monetary policy on the stock markets of Canada (one of the first countries to adopt an explicit inflation target in 1991) and the United States (a country which has not set an explicit inflation target) document that rises in the monetary policy instrument interest rate are far more greater in magnitude and more time-persistent in the US than they are in Canada. On the whole, these suggestions appear to be in line with authors such as Bean (2003), Lomax (2004), as well as, King (2012) who broadly argue that the adoption of an explicit inflation target by the Government and the pursuit of this target by an independent monetary policy authority can actually bolster confidence and lead to better macroeconomic results.

However, according to our results, rises in the monetary policy instrument push the stock market to remain at a highly volatile regime. This finding can be explained on the basis that during turbulent times, decisions made by the monetary policy authority are received rather warily by economic agents who feel less confident given the current disheartened economic conditions. In support of this argument, Chatziantoniou *et al.* (2013) provide evidence that within an inflationary targeting regime, rising interest rates can have a negative impact on the stock market only when fiscal policy decisions are considered in tandem. Given that fiscal policy is particularly important during economic downturns, it follows that at times of recession monetary policy decision making has an important role to play even when regime under investigation is an inflation targeting one. The profound effects of fiscal policy decision making during turbulent times have also been investigated by other authors. According to Pastor and Veronesi's (2012) review regarding the effects of fiscal policy on the economy of the US, changes in Government policy may actually involve fundamental changes in the economic environment within a country and could result in stock markets being extremely alert when it comes to fiscal policy innovations. Pastor and Veronesi (2012) attribute these concerns to the uncertainty about Government policy which unequivocally accompanies the process of policy making. In other words, during periods of increased uncertainty, monetary policy decision making is not appreciated separately from fiscal policy decision making, and thus changes in the monetary policy instrument can be a factor conducive to volatility even when the monetary authorities explicitly target inflation and pride themselves on their increased credibility and trustworthiness.

On a final note, it would be instructive at this point to refer to the issue of whether the monetary policy authority targets or responds to asset prices. Whether a central bank should respond to asset prices is still a matter open to question (see, *inter alia,* Bernanke and Gertler, 2001; Wadhwani, 2008; Blanchard et al., 2010; Allen and Rogoff, 2011). As far as the BoE is concerned Cobham (2013) documents that the MPC has long maintained that the bank does not target asset prices and that the policy reaction on asset prices movements is limited to the extent that the latter pose a threat to the overall level of inflation. In this spirit, the reaction of monetary policy to asset prices in general can be considered as a systematic response on behalf of the central bank, which fashions the level of the instrument interest rate after having taken into account the wider macroeconomic conditions that may or may not be directly related to developments in the particular market (Rigobon and Sack, 2003). Authors such as Bjornland and Jacobsen (2010) argue in favour of a key role that housing prices play in the setting of UK monetary policy. Bjornland and Leitemo (2009), further provide evidence that the stock market is very important as far as the formulation of the US monetary policy is concerned. However, the US is not explicitly inflation targeting in its monetary policy. A reconciliation is perhaps provided by Vickers (2000, p.16) who argues that as far as the UK monetary policy is concerned "*Asset prices* (merely) *inform judgments about inflation prospects*". Furthermore, Vickers (1998) and Bean (2003b) among many others put forward the argument that the UK monetary policy is not really one-dimensional as income considerations and low output volatility always accompany inflation considerations. Irrespective of what the decision of the monetary authority is, our findings suggest that monetary policy decisions can affect the current regime of both the housing and the stock market.

5. Conclusion

The objective of this study is twofold. First, we employ the Markov regime switching method in order to identify one low risk and one high risk regime for both the housing and the stock market of the UK economy. Second, we employ a probit regression framework in order to assess the impact of monetary policy decision making on the probability that each market remains at the high risk state. We are particularly interested in this latter issue, as any strong statistical evidence towards this direction can provide us with the ability to make forecasts regarding the potential future state of either market.

Our findings suggest that there exist two distinct regimes for each of the UK housing and the UK financial market. In addition, we provide evidence in favour of the fact that higher short term interest rates induce the stock market to remain at the high volatility regime. Results regarding the housing market are inconclusive. However, in both markets, rises in the level of inflation have a key role to play and this information is considerably valuable within an inflation targeting monetary policy regime. We maintain that our findings are particularly useful to policy makers, as evidently, our analysis has some degree of predictive power and can be used in monetary policy decision making. Given that the economy under investigation has adopted an inflation targeting monetary policy regime, results highlight the importance of the general economic conditions for the conduct of monetary policy in the UK economy.

Avenues for future research may include the consideration of a greater number of regimes (especially for the housing market), as well as, performing out of sample forecasts. Finally, a time varying transition probabilities framework; that is, one that allows for linkages between the transition probabilities and other macroeconomic or financial variables can also be an interesting area for future work.

References

Allen, F., adn Rogoff, K. (2011). Asset prices, financial stability and monetary policy. http://fic.wharton.upenn.edu/fic/papers/11/11-39.pdf, [accessed by: May, 2013]

Ang, A., and Bekaert, G. (1998). *Regime switches in interest rates*. (Working Paper 6508). Cambridge Massachusetts: National Bureau of Economic Research (NBER).

Ang, A., and Bekaert, G. (2002). International asset allocation with regime shifts. *Review of Financial Studies, 15*, 1137-1187.

Ang. A., and Timmermann, A. (2011). *Regime changes and financial markets*. (Working Paper 17182). Cambridge Massachusetts: National Bureau of Economic Research (NBER).

Arestis, P, and Karakitsos, E. (2009). *Subprime mortgage market and current financial crisis*. (Working Paper: CCEPP WP08-09). Cambridge Centre for Economic and Public Policy.

Baker, S., Bloom, N., Davis, S. (2013). *Measuring economic policy uncertainty*. Chicago Booth Research Paper (13-02).

Bank of England (BoE). (2013). Inflation Report, May 2013. http://www.bankofengland.co.uk/publications/Documents/inflationreport/2013/ir13feb.pdf, [accessed by: May, 2013]

Barker, K. (2004). *Delivering stability: Securing our future housing needs*. Barker Review of Housing Supply: Final Report – Recommendations: London: HMS-Treasury.

Bean, C. (2003a). *Inflation targeting: The UK experience*. Speech by Charles Bean, Chief Economist and Member of the Monetary Policy Committee at the Annual Congress of the German Economic Association, University Zurich-Irchel in Switzerland. http://www.bankofengland.co.uk/publications/Documents/speeches/2003/speech203.pdf, [accessed by: March 2012]

Bean, C. (2003b). *Asset prices, financial imbalances and monetary policy: Are inflation targets enough?* Speech by Charles Bean, Chief Economist and Member of the Monetary Policy Committee at the conference on "Monetary Stability, Financial Stability and the Business Cycle" at the Bank for International Settlements, Basel, 28-29 March 2003.

Becker, R., Osborn, D.R., and Yildirim, D. (2012). A threshold cointegration analysis of interest rate pass-through to UK mortgage rates. *Economic Modelling, 29*(6), 2504-2513.

Bekaert, G., Harvey, C.R., and Lundblad, C. (2007). Liquidity and expected returns: Lessons from emerging markets. *Review of Financial Studies, 20*(6), 1783-1831.

Bernanke, B.S., and Gertler, M. (2001). Should central banks respond to movements in asset prices? *American Economic Review, 91*, 253-257.

Bernanke, B.S., & Kuttner, K.N. (2005). What explains the stock market's reaction to Federal Reserve policy? *Journal of Finance*, *60*(3), 1221–1257.

Bjornland, H.C. and Jacobsen, D.H. (2010). The role of house prices in the monetary policy transmission mechanism in small open economies. *Journal of Financial Stability, 6*, 218-229.

Bjornland, H.C., and Leitemo, K. (2009). Identifying the interdependence between monetary policy and the stock market. *Journal of Monetary Economics, 56*(2), 275-282.

Blanchard, O., Dell' Ariccia, G., and Reinhart, V.R. (2010). Rethinking monetary policy. *Journal of Money, Credit and Banking, 42*(s1), 199-217.

Bomfim, A.N. (2003). Pre-announcements effects, news effects and volatility: Monetary policy and the stock market. *Journal of Banking and Finance, 27*(1), 133-151.

Bone, J., and O'Reilly, K. (2010). No place called home: The causes and consequences of the UK housing bubble. The British Journal of Sociology, 61(2), 231-255.

Bridges, J., and Thomas, R. (2012). The impact of QE on the UK economy: Some supportive

Brunnermeier, M.K., and Julliard, C. (2008). Money illusion and housing frenzies. *Review of Financial Studies, 21*, 135-180.

Carstensen, K., Hülsewig, O., and Wollmershaüser, T. (2009). *Monetary policy transmission and house prices: European cross-country evidence*. (Working Paper 2750). Centre for Economic Studies & Institute for Economic Research (CESifo).

Castelnuovo, E., and Nisticò, S. (2010). Stock market conditions and monetary policy in a DSGE model for the U.S. *Journal of Economic Dynamics and Control, 34*(9), 1700-1731.

Chandler, D., and Disney, R. (2014). *Housing market trends and recent policies*. In C. Emmerson, P. Johnson and H. Miller (eds), The IFS Green Budget: February 2014, Report no. R91, London: Institute for Fiscal Studies (http://www.ifs.org.uk/publications/ 7072).

Chatziantoniou, I., Duffy, D., and Filis, G. (2013). Stock market response to monetary and fiscal policy shocks: Multi-country evidence. *Economic Modelling, 30*, 754-769.

Chen, S.S., 2007. Does monetary policy have asymmetric effects on stock returns? *Journal of Money, Credit and Banking 39*, 667–688.

Chen, S.S. (2010). Do higher oil prices push the stock market into bear territory? *Energy Economics, 32*, 490-495.

Cobham, D. (2013). Central banks and house prices in the run-up to the crisis. *Oxford Economic Papers, 65*(1), 42-61.

Department of Communities and Local Government. (2011). *English Housing Survey: Household report 2009-2010*. London: DCLG.

Dvornak, N., and Kohler, M. (2007). Housing wealth, stock market wealth and consumption: A panel analysis for Australia. *Economic Record, 83*(261), 117-130.

Garcia, R. (1998). Asymptotic null distribution of the likelihood ratio test in Markov switching models. *International Economic Review, 39*(3), 763-788.

Guidolin, M. and A. Timmermann. (2005). Economic implications of bull and bear regimes in UK stock and bond returns. *Economic Journal, 115*, 111-143.

Hall, S., Psaradakis, Z., and Sola, M. (1997). Switching error-correction models of house prices in the United Kingdom. *Economic Modelling, 14*, 517-527.

Hamilton, J.D. (1989). A new approach to the economic analysis of nonstationary time series

Hamilton, J.D. (2008). *Regime-switching models*. In the New Palgrave Dictionary of Economics (2nd ed.). Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave, MacMillan.

Hay, C. (2009). Good inflation, bad inflation: The housing boom, economic growth and the disaggregation of inflationary preferences in the UK and Ireland. *The British Journal of Politics and International Relations, 11*(3), 461-478.

Himmelberg, C., Mayer, C., and Sinai, T. (2005). *Assessing high house prices: Bubbles, fundamentals and misperceptions*. (Staff Report 218). Federal Reserve Bank of New York.

Iacoviello, M., and Minetti, R. (2003). Financial liberization and the sensitivity of house prices to monetary policy: Theory and evidence. *The Manchester School, 71*, 20-34.

Iacoviello, M., and Neri, S. (2007). Housing market spillovers: Evidence from an estimated DSGE model. *American Economic Journal: Macroeconomics, 2*(2), 125-164.

Ismail, M.T., and Isa, Z. (2008). Identifying regime shifts in Malaysian stock market returns. *International Research Journal of Finance and Economics, 15*, 44-57.

King, M. (2012). *Twenty years of inflation targeting*. Speech given by Mervin King, Governor of the Bank of England, on October 9th, 2012. The Stamp Memorial Lecture, London School of Economics. www.bankofengland.co.uk/publications/Pages/speeches/default.aspx, [accessed, December, 2012]

King, R.G., and Watson, M.W. (1996). Money, Prices, Interest Rates and the Business Cycle. *The Review of Economics and Statistics, 78*(1), 35-53.

Kuenzel, R., and Bjørnbak, B. (2008). *The UK housing market: anatomy of a house price boom*. Economic analysis from the European Commission's Directorate-General for Economic and Financial Affairs, Volume 5(11). http://ec.europa.eu/economy_finance/publications/publication13282_en.pdf, [accessed by: June, 2013]

Kurov, A. (2010). Investor's sentiment and the stock market's reaction to monetary policy. *Journal of Banking and Finance, 34*, 139-149.

Lastrapes, W.D. (2002). The real price of housing and money supply shocks: Time series evidence and theoretical simulations. *Journal of Housing Economics, 11*, 40-74.

Laurini, M.P., and Portugal, M.S. (2004). Long memory in the R$/US$ exchange rate: A robust analysis. *Brazilian Review of Econometrics, 24*, 109-147.

Lawrence, C.T., and Tits, A.L. (2001). A computationally efficient feasible sequential quadratic programming algorithm. *Siam Journal on optimization, 11*(4), 1092-1118.

Li, Y.D., Iscan, T.B., and Xu. K. (2010). The impact of monetary policy shocks on stock prices: Evidence from Canada and the United States. *Journal of International Money and Finance, 29*(5), 876-896.

Lomax, R. (2004). *Inflation targeting: Achievement and challenges*. Speech by Rachel Lomax to the Bristol Society at the University of West England, Bristol.
http://www.bankofengland.co.uk/publications/Pages/speeches/2004/215.aspx
[accessed by: November 2011]

Maheu, J.M., and McCurdy, T.H. (2000). Identifying bull and bear markets in stock returns. *Journal of Business and Economic Statistics, 18*, 100-112.

McQuinn, K, and O'Reilly, G. (2008). Assessing the role of income and interest rates in determining house prices. *Economic modelling, 25*, 377-390.

Miles, D. (2004). The UK mortgage market: Taking a longer-term view. Report to HM Treasury. http://62.164.176.164/d/miles04_470[1].pdf [accessed by: June, 2013]

Mishkin, F.S. (2001). *The transmission mechanism and the role of asset prices in monetary policy*. (Working Paper 8617). Cambridge Massachusetts: National Bureau of Economic Research (NBER).

Mishkin, F.S. (2007). *Housing and the monetary transmission mechanism*. Board of Governors of the Federal Reserve System, August 2007.

Morley, B, and Thomas, D. (2011). Risk-return relationships and asymmetric adjustments in the UK housing market. *Applied Financial Economics, 21*(10), 735-742.

Nneji, O., Brooks, C., and Ward, C.W.R. (2013). House price dynamics and their reaction to macroeconomic changes. *Economic Modelling, 32*, 172-178.

Office for National Statistics (ONS). (2012). *Ownership of UK quoted shares, 2010*. Statistical Bulletin, February 2012. http://www.ons.gov.uk/ons/dcp171778_257476.pdf, [accessed by: March, 2012]

Office for National Statistics (ONS). (2013a). *House price index. December, 2012*. Statistical Bulletin, March, 2013. http://www.ons.gov.uk/ons/dcp171778_298817.pdf, [accessed by: April, 2013]

Office for National Statistics (ONS). (2013b). *Consumer price inflation*. Statistical Bulletin, March 2013. http://www.ons.gov.uk/ons/dcp171778_306185.pdf, [accessed by: May, 2013]

Pan, W., Alistair, G.F., and Dainty, A.R.J. (2007). Perspectives of UK house builders on the use of offsite modern methods of construction. *Construction Management and Economics 25*(2), 183-194.

Pastor, L., and Veronesi, P. (2012). Uncertainty about Government policy and stock prices. *The Journal of Finance, 67*(4), 1219-1264.

Piger, J. (2009). *Econometrics: Models of regime changes*. In Encyclopaedia of Complexity and Systems Science, p. 2744-2757, edited by Robert A. Meyers, Springer.

Poon, J., and Garratt, D. (2012). Evaluating UK housing policies to tackle housing affordability. *International Journal of Housing Markets and Analysis, 5*(3), 253 - 271.

Reinold, K. (2011). *Housing equity withdrawal since the financial crisis*. Quarterly Bulletin, 2011:Q2. Bank of England (BoE).

Rigobon, R., and Sack, B. (2003). Measuring the reaction of monetary policy to the stock market. *The Quarterly Journal of Economics, 118*(2), 639-669.

Schaller, H., and Norden, S. (1997). Regime switching in stock market returns. *Applied Financial Economics, 7*, 177-192.

Schwert, G.W. (2011). Stock volatility during the recent financial crisis. *European Financial Management, 17*(5), 789-805.

Sims, C.A. (2003). Implications of rational inattention. *Journal of Monetary Economics, 50*(3), 665-690.

Sousa, R.M. (2010). Housing wealth, financial wealth, money demand and policy rule: Evidence from the euro area. *North American Journal of Economics and Finance 21*, 88-105.

Stiglitz, J. (2010). *Risk and global economic architecture: Why full financial integration may be undesirable*. (Working Paper No. 15718). National Bureau of Economic Research (NBER).

Thorbecke, W. (1997). On stock market returns and monetary policy. *The Journal of Finance, 52*(2), 635-654.

Tsai, I.C., Chen, M.C., and Ma, T. (2010). Modelling house price volatility states in the UK by switching ARCH models. *Applied Economics, 42*(9), 1145-1153.

Tsatsaronis, K., and Zhu, H. (2004). *What drives house price dynamics: Cross-country evidence*. Quarterly Review (March 2004), Bank for International Settlements (BIS).

Turner, M.C., Startz, R., and Nelson, C.F. (1989). A Markov model of heteroskedasticity, risk and learning in the stock market. *Journal of Financial Economics, 25*, 3-22.

Vickers, J. (2000). Monetary policy and asset prices. *The Manchester School, 68*, Issue Supplement s1, 1-22.

Wadhwani, S. (2008). Should monetary policy respond to asset price bubbles? Revisiting the debate. *National Institute Economic Review, 206*, 25-34.

Walsh, C.E. (2009). Inflation targeting: What have we learned? *International Finance, 12*(2), 195-233.

Figures

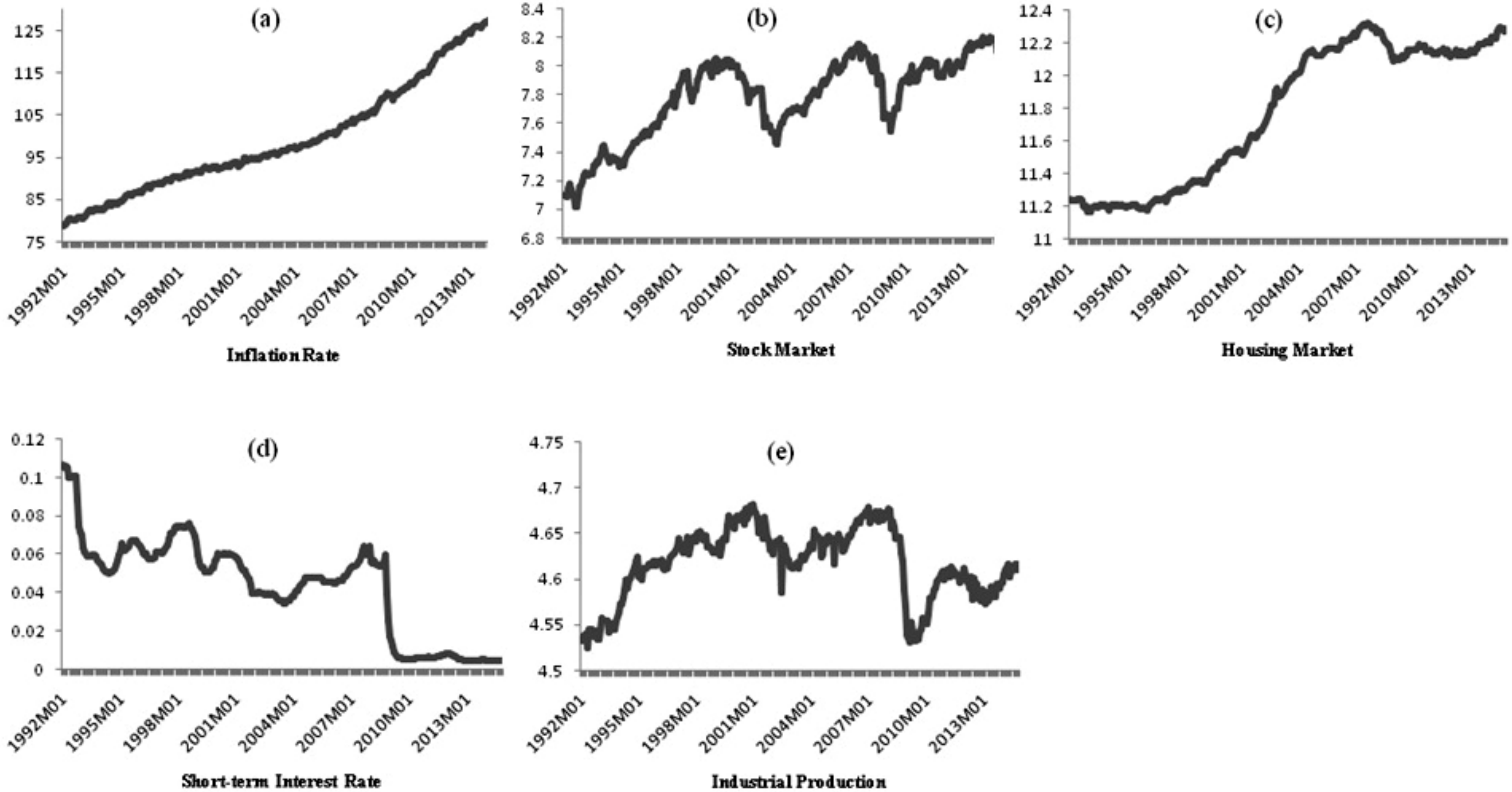

Figure 1: Macroeconomic and financial variables employed in the study (in levels, seasonally adjusted, constant prices).

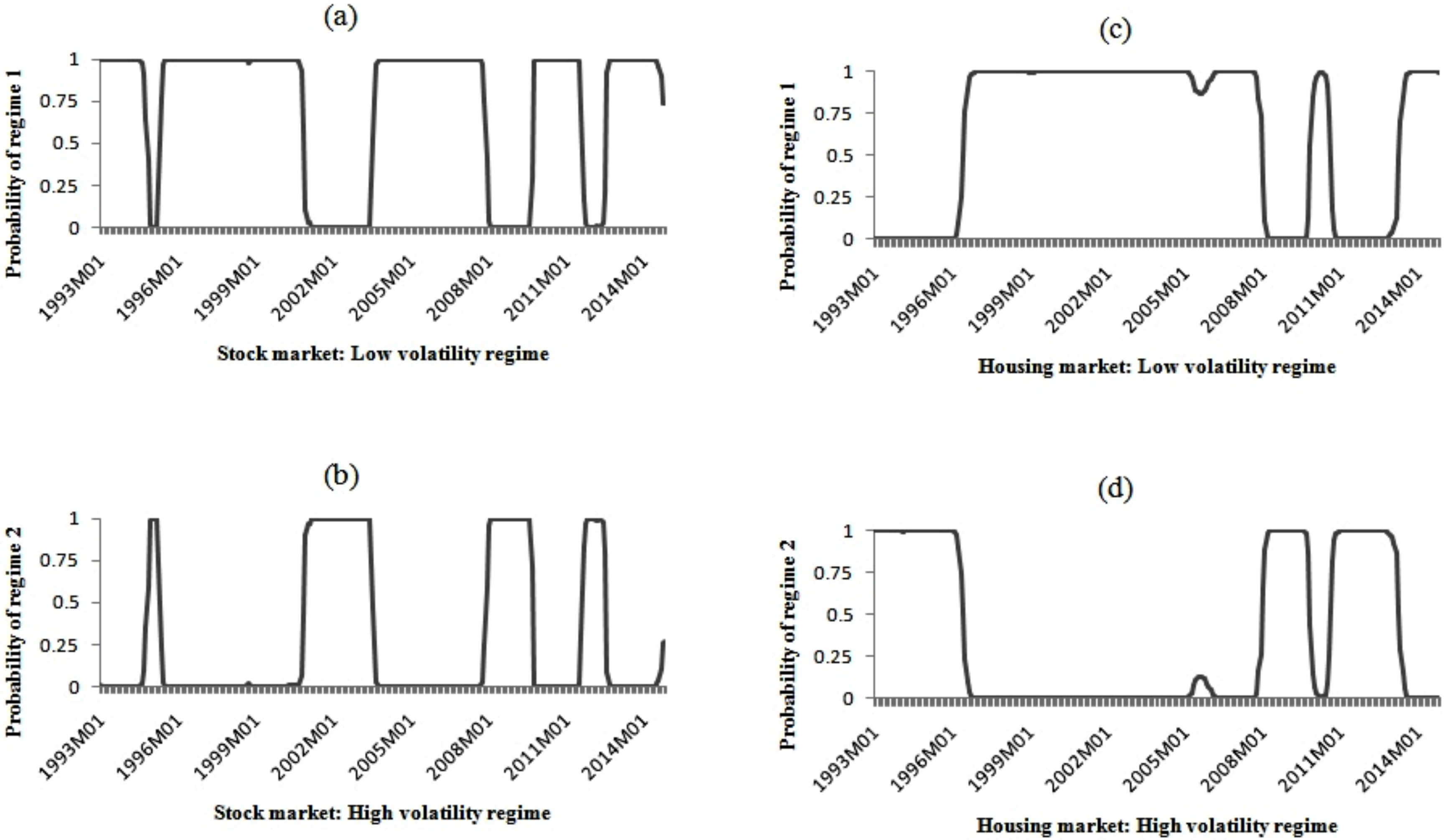

Figure 2: Low volatility regimes, high volatility regimes and their corresponding probabilities.

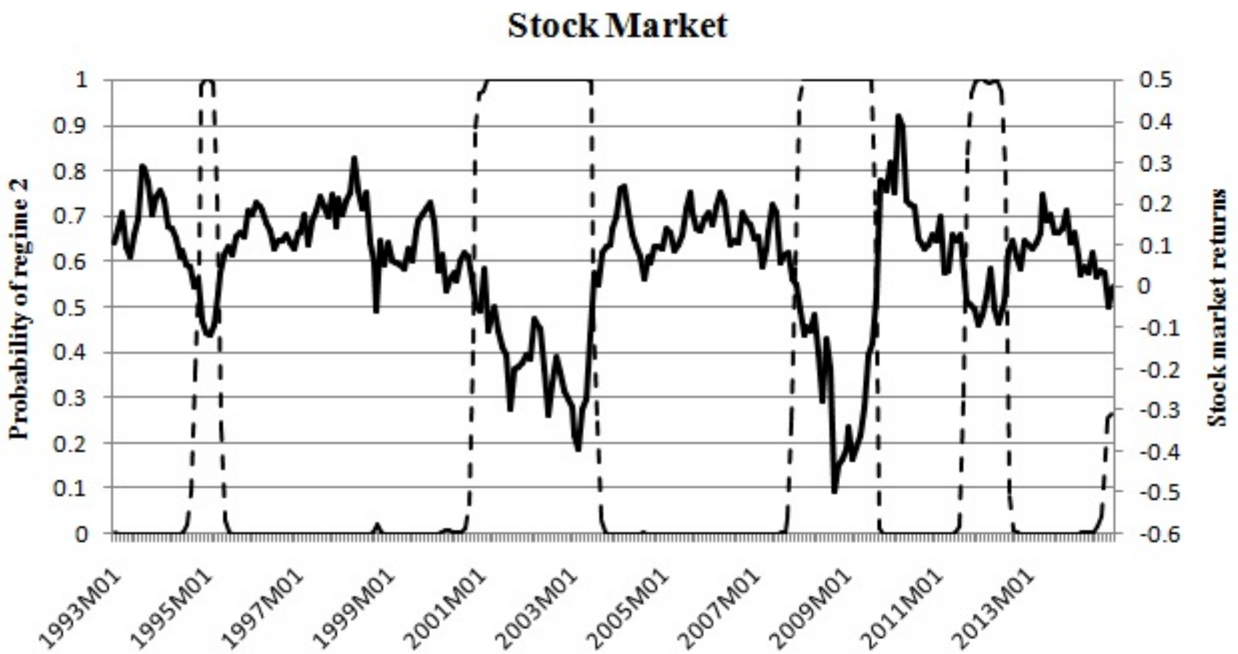

Figure 3**:** Regime dominance for the stock market in relation to stock market returns.

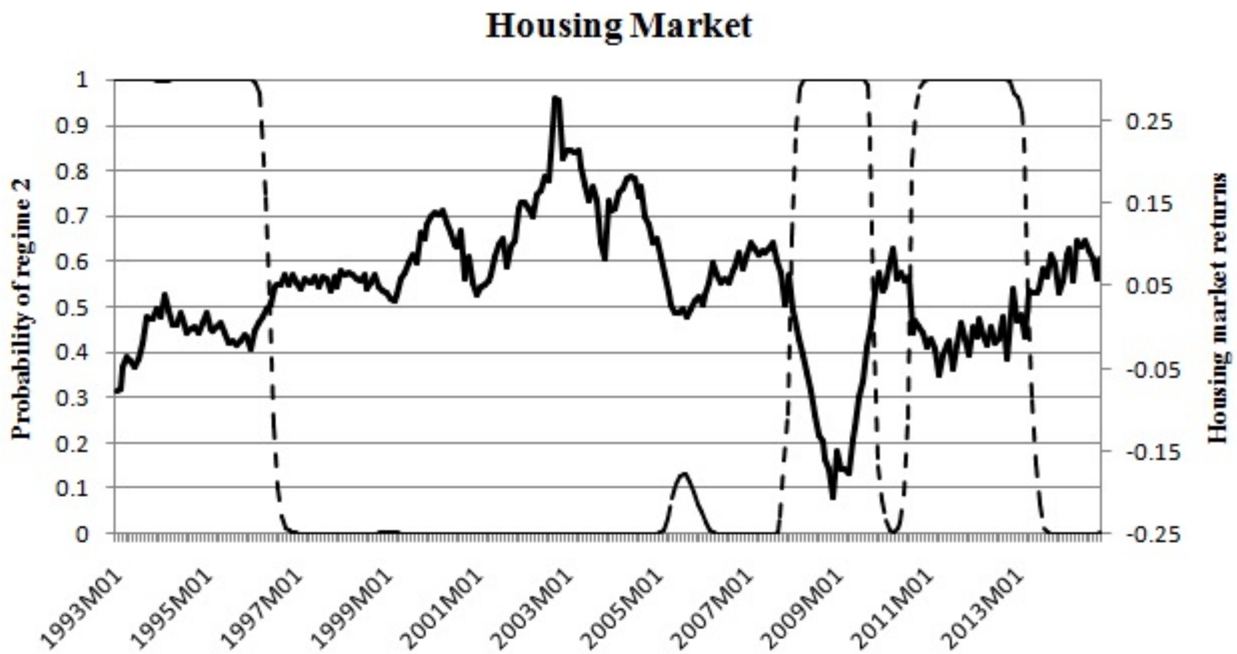

Figure 4**:** Regime dominance for the housing market in relation to housing market returns.

Tables

Table 1: Estimated coefficients of the regime switching model MS-AR(0) for FINANCIAL PRICES			
μ_1	0.127228	***	(0.000)
μ_2	-0.161506	***	(0.000)
σ_1	0.073896	***	(0.004)
σ_2	0.131138	**	(0.011)
ρ_{11}	0.977325	**	(0.011)
ρ_{22}	0.941808	**	(0.028)
RCM	6.019		

*Notes: p-values in parentheses. p-values are calculated on the basis of both autocorrelation and heteroskedasticity-robust standard errors. In addition, ***, ** and * denote* < 0.01, $p < 0.05$, *and* $p < 0.1$ *respectively.*

Table 2: Estimated coefficients of the regime switching model MS-AR(0) for HOUSING PRICES			
μ_1	0.090923	***	(0.000)
μ_2	-0.027249	***	(0.000)
σ_1	0.052317	***	(0.003)
σ_2	0.055131	***	(0.004)
ρ_{11}	0.986006	***	(0.009)
ρ_{22}	0.967487	**	(0.018)
RCM	7.005		

*Notes: p-values in parentheses. p-values are calculated on the basis of both autocorrelation and heteroskedasticity-robust standard errors. In addition, ***, ** and * denote* < 0.01, $p < 0.05$, *and* $p < 0.1$ *respectively.*

Table 3: Probit Regression Results for FINANCIAL PRICES.
(depended binary variable: Probability of the high volatility regime)

	EQUATION					
VARIABLES	(1)		(2)		(3)	
Constant	-2.072	***	-0.379		-2.577	**
Short term interest rate$_{t-1}$	1.528				20.359	*
Binary$_{t-1}$	3.630	***			1.510	**
FTSE$_{t-1}$			-22.721	***	-16.379	***
HALIFAX$_{-t-1}$			-7.072	*	-4.687	
Inflation$_{t-1}$			15.945		34.801	*
R^2	0.77		0.82		0.86	

*Notes: p-values in parentheses. p-values are calculated on the basis of both autocorrelation and heteroskedasticity-robust standard errors. In addition, ***, ** and * denote* $p < 0.01$, $p < 0.05$, *and* $p < 0.1$ *respectively.* $S_t = 2$ *is the high volatility regime for the stock market.*

Table 4: Probit Regression Results for HOUSING PRICES.
(depended binary variable: Probability of the high volatility regime)

VARIABLES	EQUATION (1)		(2)		(3)	
Constant	-2.193	***	-0.379		-5.468	***
Short term interest rate$_{t-1}$	-2.647				14.505	
Binary$_{t-1}$	4.076	***			2.809	***
HALIFAX$_{t-1}$			-73.724	***	-37.326	***
FTSE$_{t-1}$			-10.748	***	-11.540	***
Inflation$_{t-1}$			227.876	***	269.390	***
R^2	0.86		0.86		0.92	

*Notes: p-values in parentheses. p-values are calculated on the basis of both autocorrelation and heteroskedasticity-robust standard errors. In addition, ***, ** and * denote* $p < 0.01$, $p < 0.05$, *and* $p < 0.1$ *respectively.* $S_t = 2$ *is the high volatility regime for the stock market.*