Urban Studies, Vol. 42, No. 10, 1755–1769, September 2005

Routledge Taylor & Francis Group

A Dynamic Analysis of Mortgage Arrears in the UK Housing Market

Catarina Figueira, John Glen and Joseph Nellis

[Paper first received, June 2004; in final form, February 2005]

Summary. The UK economy has enjoyed an unprecedented period of positive economic growth since the early 1990s. The absence of recession for more than a decade has been accompanied by a sustained decline in the level of mortgage arrears, as reported by major lenders. This paper seeks to examine the factors which have driven the reduction in mortgage arrears and, in doing so, identify those factors which are most likely to cause arrears to increase in the future, should economic conditions deteriorate. The paper employs the Johansen methodology to test for the presence of multiple cointegrating vectors. An error correction model is estimated in order to examine long-run and short-run dynamics in mortgage arrears. In line with previous research concerning the causes of mortgage arrears, the results presented here emphasise the importance of changes in the rate of unemployment, loan–income and debt–service ratios. More importantly, our results highlight the statistical significance of unwithdrawn housing equity as an explanatory variable with respect to mortgage arrears.

1. Introduction

According to official statistics for the UK, more than 389 000 properties were possessed by lenders between 1990 and 1996, which affected more than 1 million individuals (Council of Mortgage Lenders, 1997). Possessions are invariably the result of an extended period of financial distress during which individuals and households have accumulated arrears. This paper seeks to examine those factors which influence the aggregate level of arrears on the mortgage book of a number of major UK banks and building societies.

The UK housing market has experienced considerable turbulence since the early 1980s (Ford, 1997). The market has witnessed several periods of rapidly rising house prices, such as occurred between 1982 and 1989. However, between 1990 and 1992, a sharp downturn in activity was reported, resulting in a dramatic reversal in house price inflation. Since 1992/93, the UK economy has enjoyed a period of steady growth, accompanied by a sustained decline in unemployment and a strong rise in earnings. As a consequence, the market has again reported record increases in average house price inflation across the UK, originating in London and the South East region, with the consequent 'ripple effect' northwards. This latest boom has renewed fears that the UK housing market is again overheating, thereby increasing the probability of another crash similar to that experienced in the early 1990s. It is in this context of a sustained house price boom that the level of mortgage arrears has significantly decreased, as accounted for by the UK major lenders.

Catarina Figueira, John Glen and Joseph Nellis are in the Cranfield School of Management, Cranfield University, Cranfield, Bedfordshire, MK43 0AL, UK. Fax: +44 1234 752 136. E-mail: Catarina.Figueira@cranfield.ac.uk; John.Glen@cranfield.ac.uk; and J.G.Nellis@cranfield.ac.uk. *The authors wish to thank Ed Coulsen, conference participants at the North American Regional Science Conference and Cranfield Research Colloquium and three anonymous referees for helpful comments on an earlier version of this paper.*

0042-0980 Print/1360-063X Online/05/101755–15
DOI: 10.1080/00420980500231670

This paper seeks to examine the variables which have driven the reduction of mortgage arrears and, in doing so, identify those factors which are most likely to cause this situation to reverse should conditions in the UK economy deteriorate in the future. We examine the path of mortgage arrears in the period from 1993 to 2001, based on a unique database compiled from the detailed profile of borrowers from a consortium of major mortgage lenders. In the context of our analysis, it should be noted that we are only concerned with arrears involving mortgages for a specific sub-section of the UK housing market—namely, the owner-occupied sector; we are not concerned with arrears involving rents in the public and private sectors.

The remainder of the paper is organised as follows. Section 2 presents the past and more recent developments in the UK housing market in order to put the study reported here into context; section 3 examines the pattern of mortgages, mortgage arrears and mortgage possessions since the mid 1980s; section 4 describes the framework which we employ to model mortgage arrears and a description of the data; section 5 sets out the econometric methodology, while section 6 presents and discusses the empirical results. Finally, section 7 summarises and sets out the main conclusions of the paper.

2. Developments in the UK Housing Market

The structure and nature of the UK housing market are the result of a trend which has seen the proportion of personal-sector wealth held in the form of owner-occupied dwellings increase dramatically over many years. Owner-occupied dwellings accounted for approximately 40 per cent of the net wealth of the personal sector in 1990 compared with around 20 per cent in 1960. The UK has one of the highest owner-occupation rates in the world and one of the lowest levels of private renting. In 1991, 68 per cent of households were owner-occupied, whereas this was a mere 10 per cent in 1914 (Miles, 1993). The period 1981–89 saw a rapid growth in the number of home-owners from 11.9 million to 15 million and the number of mortgage holders grew from 6.2 million to 9.1 million households (Maclennan and Gibb, 1993).

The early 1980s saw a sharp downturn in housing market activity, with house prices remaining almost static in 1980 and 1981.[1] This stagnation has to be placed in an historical context. A Conservative government came to power in 1979 with an agenda which encouraged home-ownership (Moore, 1992). Two specific areas of government policy were central to the growth of home-ownership. First, a 'Right-to-Buy' policy saw 1.45 million properties transferred from the 'social rented' sector to the private owner-occupied sector between 1980 and 1992.[2] At the same time, deregulated financial markets generated a highly competitive financial environment (Coakley and Harris, 1992) as well as the end of credit rationing (Michie and Wilkinson, 1992). This policy, and the liberalisation of financial markets in the 1980s, the Financial Services Act 1986 and the Building Societies Act 1986 (Harrington, 1996), were key drivers of the turbulence in the housing market in the late 1980s and early 1990s.

Increased competition between lenders resulted in borrowers being able to acquire loans which were a greater percentage of the value of their properties and a higher multiple of their incomes. This resulted in household-sector mortgage indebtedness increasing from less than 25 per cent of annual disposable income in 1980 to around 75 per cent in 1992 (Brookes *et al.*, 1994). The average mortgage advance increased from 46.1 per cent of the house price in 1980 to a peak of 60.1 per cent in 1986, remaining at 58 per cent for the rest of the 1980s. For first-time buyers, the average advance increased from 73.8 per cent of the house price in 1980 to a peak of 84.4 per cent in 1988 (Council of Mortgage Lenders, 1994).

The combination of increased demand for housing, due to rising incomes, and increased competition to supply mortgage lending fuelled house price inflation. According to

official statistics, real house prices rose, on average, by over 4.5 per cent per annum during the 1980s, with nominal house price inflation peaking at 28 per cent in 1988. As house prices increased, borrowers increased their gearing and those at the lower end of the income scale with no deposit were amongst the most highly geared borrowers. Accelerating property prices also increased the equity which many long-term borrowers have in their property. By 1989, it was estimated that 24 per cent of borrowers had extended their loans and drawn down the equity in their property values.

However, the price inflation generated by the 'Lawson Boom'[3] of the late 1980s (Coakley and Harris, 1992)[4] led to the inevitable adoption of a restrictive monetary policy and a tightening of interest rates—with mortgage rates doubling during a 16-month period from September 1988 to January 1990, peaking at over 15 per cent.

The combination of a restrictive monetary stance and the ensuing economic recession of the early 1990s caused the housing market to weaken considerably—nominal house prices across the UK fell, on average, by around 7.5 per cent between 1990 and 1992 which was unprecedented in the previous 40 years (Council of Mortgage Lenders, 1994). The severity of the decline in house prices was also matched by the longevity of the slump in the housing market. Real prices declined by 6.25 per cent per annum from 1989 to 1994 and by a further 2.5 per cent in 1995 (Pain and Westaway, 1997). A significant number of households found themselves in the position where they were unable to meet their mortgage repayment schedules and they fell into arrears, ultimately resulting in an increased level of possessions by lenders, up from 16 000 in 1989 to 75 500 in 1991 (Malpass and Murie, 1999).

Borrowers in arrears came from a wider spectrum of home-buyers than had previously been the case in terms of age, occupational status and family composition. Job losses due to redundancy, small business failure and reduced earnings were the major triggers of arrears. Retrospectively, lenders were perceived to have responded slowly to the growth of arrears, only securing the earlier intervention contact and assessment after a period of time.

Ortalo-Magné and Rady (1999) argue that a sustained growth in incomes and a relaxed credit constraint for younger borrowers were critical in explaining the boom in the 1980s property market. They further argue that the negative credit market shock, which the UK mortgage market experienced in the late 1980s and early 1990s, was a unique event and was unlikely to be repeated.

3. The Pattern of Mortgage Arrears

The impetus for the research we report in this paper stems from the observed pattern of mortgage arrears in the UK housing market since the mid 1980s. In the past, financial institutions typically developed a 'score card' methodology to predict future refinancing problems on the part of mortgage borrowers. Such an approach seeks to identify a series of trigger events that are associated with mortgage arrears. By the late 1990s, this score card approach systematically overestimated the actual level of arrears. The observed behaviour of mortgage data generated a second concern—namely, that the incidence of arrears had shifted from its long-run equilibrium level. In the context of these recent developments, this paper develops an econometric model in order to assess the extent to which the incidence of mortgage arrears has diverged from its long-run equilibrium level and how swiftly it may return to that level.

As can be seen from Figure 1, the number of mortgages granted in the UK increased steadily over the period considered in this paper (1985–2001). Nevertheless, since 1993, the number of mortgages in arrears has decreased significantly, along with the number of possessions (Figure 2), despite the 1995 changes to the entitlement to welfare benefit concerning mortgage interest[5] and growth in the mortgage payment protection insurance (MPPI).[6] Later in the paper, empirical tests provide evidence of the fact

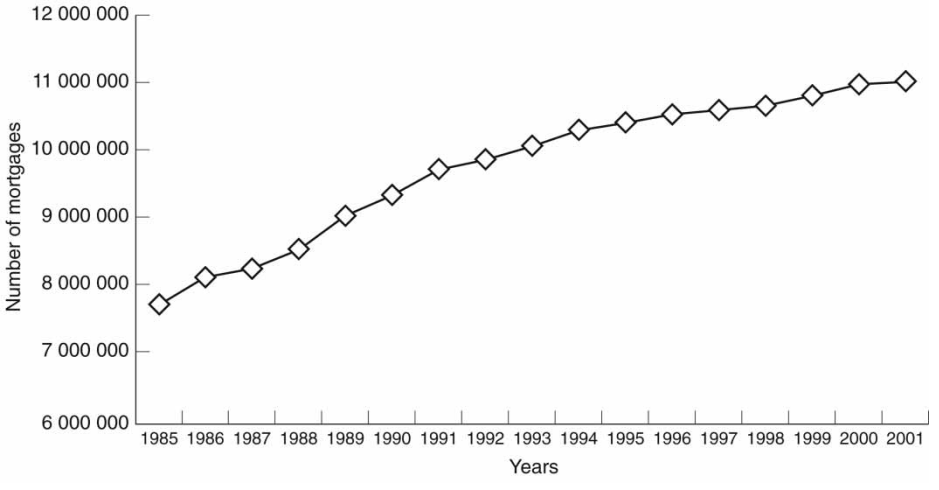

Figure 1. UK mortgages, 1985–2001. *Source*: Housing Finance, Council of Mortgage Lenders.

that the above factors did not contribute to structural breaks over time in the model presented.

Three main factors appear to be responsible for the decline in the number of mortgage arrears and possessions. First, after the 'boom and bust' of the late 1980s and early 1990s, it may be argued that banks and building societies have improved their procedures for measuring the risk associated with supplying mortgages to different types of borrowers. This, therefore, has equipped them with a greater depth and refinement of information for assessing lending risk and the probability of mortgage default. Secondly, it may also be argued that borrowers have become better informed and more cautious about choosing particular mortgage products than previously. Finally, competitive pressures have resulted in many financial institutions nowadays offering low-margin mortgages (Harrington, 1996).[7] The outcome is that customers have become less loyal to lenders, more discerning about financial products and, hence, more active in searching for the best-value offerings in the market, resulting in reduced monthly

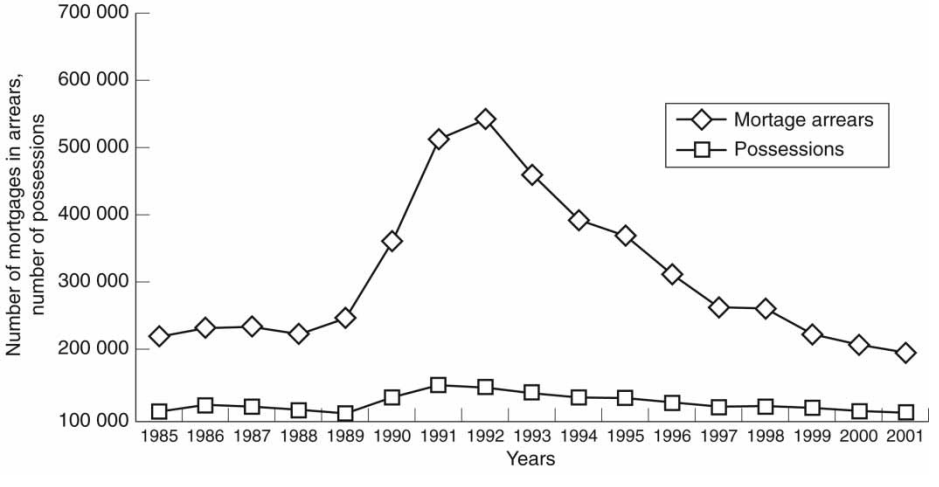

Figure 2. Mortgages in arrears and possessions. *Source*: Housing Finance, Council of Mortgage Lenders.

mortgage payments for many, as suggested by Aoki *et al.* (2001).

As a result, the negative impact of the abolition of tax relief on mortgage interest on house prices, housing consumption and, ultimately, home-ownership was offset by changes in borrowers' behaviour and household leverage, as claimed in Hendershott *et al.* (2002).[8]

With respect to the analysis of mortgages in arrears, three main periods are normally considered: 3–6 months in arrears, 6–9 months in arrears and over 12 months in arrears. Figure 3 shows that mortgages in arrears follow the same pattern in the three periods analysed.

It will be seen that the general pattern of mortgages in arrears increased sharply from the end of 1989 to 1992. Thereafter, the number of arrears has been in a downward trend. This has been *in tandem* with a steady decline in the national level of unemployment in the UK, which has reached historically low levels. Moreover, the nature of this unemployment has tended to be primarily short-term (so-called frictional unemployment), further contributing significantly to the decrease in arrears.

However, the number of mortgages in arrears for 3–6 months seems to be more volatile than the number of mortgages in arrears in the other two periods. This is due to the fact that many borrowers will typically attempt to delay the payment of their mortgage instalments for a few months, when they are faced with what they perceive to be temporary changes in their net income and/or expenditure. In such circumstances, mortgagors will rectify the delay in paying their instalments without any major action being taken by the financial institutions concerned. Moreover, many mortgage borrowers make use of the net asset value contained in their property—i.e. the property value minus the outstanding value of the mortgage (referred to as 'unwithdrawn equity')—and, as a consequence, negotiate new contracts with the bank or building society.

The housing literature identifies a number of particular factors in the explanation of the dynamics of mortgage arrears. The *levels* of unemployment and redundancies are identified as key drivers of the aggregate level of arrears by Doling *et al.* (1988) and Ford *et al.* (1995), while Brookes *et al.* (1994) identify increased *inflows* into unemployment as an important factor. The relationship between the age of the head of household and arrears has been also examined by Ford (1993) and Nettleton and Burrows (1998). In

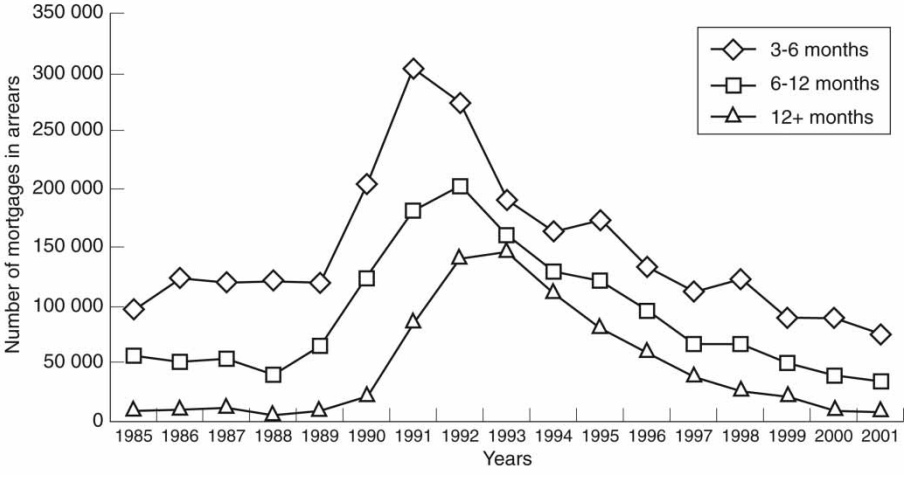

Figure 3. Mortgages in arrears: 3–6, 6–9 and over 12 months. *Source*: Housing Finance, Council of Mortgage Lenders.

addition, Ford and Burrows (1998) have found evidence that the younger the head of the household, the greater the probability of experiencing arrears. Furthermore, Böheim and Taylor (1999) suggest that the increased incidence of periods of unemployment experienced by younger workers explains their increased propensity to experience mortgage arrears.

Several US studies have also emphasised the importance of equity on mortgage default, such as Jackson and Kaserman (1980) and Williams *et al.* (1974). Case *et al.* (1995) claim that periods of high default rates on home mortgages in the US are closely associated with a decrease in unwithdrawn equity, derived from decreases in real estate prices. The following framework investigates these relationships.

4. Modelling Framework and Data

4.1 Modelling Framework

The theoretical model presented in this paper stems from earlier research by Wadhwani (1986), which examined the frequency of corporate bankruptcies. Brookes *et al.* (1991) were the first to apply Wadhwani's theoretical framework to the analysis of mortgage default. This original framework has been further developed by Breedon and Joyce (1993) and Brookes *et al.* (1994). The model is based on the assumption that an individual and/or household who can afford to buy a house chooses to buy instead of renting, as long as such a choice results in higher net returns. In other words, the individual wishes to maximise the expected utility

$$E(U) = [1 - \theta(.)][H(\delta - \varphi)] - [c\theta(.)] \quad (1)$$

where, θ is associated with the probability of mortgage payment difficulties; H is the amount of housing services; δ is the net return associated with home-ownership (after subtracting mortgage payments and other debt costs, as well as maintenance costs); φ is equivalent to the rent that the occupier would pay for the same house; and c represents costs that would be incurred if payments started to be in arrears.

In the model specified by equation (1), H is treated as a continuous variable because we assume that it also depends on the size of the house and its features; c includes the cost of paying mortgage instalments late and respective consequences (such as difficulty in obtaining housing or loans from then onwards). Therefore, c is assumed to be positively related to H.

The model is initially based on two further assumptions: there is no inflation and first-time buyers are able to obtain more finance only if the value of the property (VP) is higher than the mortgage debt (MD). The individual or household may incur mortgage payments difficulties when

$$Y - LC - \rho M + (VP - MD) < 0 \quad (2)$$

where, Y is disposable income; LC stands for other living costs; ρ is interest rate paid; and $(VP - MD)$ represents unwithdrawn equity.

Therefore, the probability of going into arrears can be represented by the following function

$$\theta(.) = \theta(Y, LC, \rho, VP - MD) \quad (3)$$

The situation becomes more complex when we take into consideration the effects of inflation. If the value of mortgages is indexed to inflation, then the model remains unchanged (if borrowers have contracts with a variable mortgage rate). Nevertheless, if this is not the case and lenders refuse to provide borrowers with new loans, then borrowers will be in arrears when

$$(Y - LC - \rho MD) < 0 \quad (4)$$

A further extension to the model is to incorporate the case when income, living expenses and interest rates rise at a rate of π, while the mortgage stock remains constant. In this case, the real rate ρ is constant. Using the Fisher condition, we can write r as $(\rho + \pi + \rho\pi)$ and the individual or household will be in

arrears if

$$(1+\pi)[Y - LC - \rho MD - \pi MD /(1+\pi)] < 0 \quad (5)$$

The above equation shows that when inflation increases, borrowers face an additional payment of $\pi MD/(1+\pi)$.

When inflation and interest rates move *in tandem*, if inflation increases then the borrower's debt–service ratio also increases and this has an important impact on those borrowers with high loan–income ratios. This, as a consequence, increases the likelihood of mortgage arrears.

This may, however, be counterbalanced by the extent that house prices also increase and borrowers release (unwithdrawn) equity in order to meet mortgage instalments. If this happens, then debt service as a percentage of the borrower's income may remain unchanged and hence the borrower will be in arrears if

$$(1+\pi)[Y - LC - \rho MD + (VP - MD)] < 0 \quad (6)$$

In practice, due to costs such as transaction costs, borrowers can only increase their loan by a proportion of the unwithdrawn equity which puts some additional strain on payment difficulties. Under these conditions, the probability of arrears will be a function of the above variables, including the extra monthly payment required, which may produce income shocks. The unemployment rate (*UR*) as well as aggregate income (*Y*) are probably the most widely used measures to account for these shocks. There are other factors such as age of borrower, relationships and administrative problems, which have an impact on arrears; however, they are difficult to measure at a macroeconomic level and hence they have been excluded from this model.[9] In addition, it is difficult to obtain an accurate measure of other living costs, and hence we use the loan–income ratio for first-time buyers (*LY*) as a proxy, since for most first-time buyers, mortgage debt payments reflect, by far, the largest element of household expenditure, as claimed by Stein (1995).[10] Finally, we use the debt–service ratio (*DS*) to capture the burden and risk associated with the increased debt mortgage repayment. The probability of arrears can then be written as

$$\theta(.) = \theta(Y/p_c, UR, VP - MD, \rho, LY, DS) \quad (7)$$

where p_c is the consumer price index.

An important point to consider in this model is that only unanticipated inflation should have an impact on the borrower's mortgage payment difficulties, which means that, in the long run, the level of inflation does not affect arrears, even though short-term changes in inflation do.

4.2 The Data

We use monthly data for England and Wales only, for the period May 1993 to April 2001. It is important to note that we have excluded data for Scotland due to the fact that there is evidence that the trends in the housing market in Scotland and the rest of the UK have differed substantially.[11] This may be due to the fact that the court system for arrears and possessions operates differently in Scotland. Moreover, the structural timing of the transition from renting to home-ownership also differs between Scotland and England and Wales.[12]

For the purpose of this study, most of the data were provided by a group of mortgage lenders. The sample constitutes approximately 36 per cent of the total mortgage book in the UK for the period under investigation, which is sufficiently large to be representative of the whole population. The remaining data have been obtained from the Office for National Statistics (ONS) and the Office of the Deputy Prime Minister (ODPM).

The dependent variable in our model is the number of arrears in excess of 3 months on the mortgage book (*ARR*) as a proportion of the total mortgages (*M*) and is presented as *ARRM*. The variable *M* includes both repayment and endowment mortgages.[13] Data on the unemployment rate (*UR*) are taken from

the ONS. Since it is extremely difficult to obtain an accurate measure of living expenses (beyond mortgage instalments), the loan–income ratio for first-time buyers (*LY*) is used here. The ratio of mortgage interest payments to real personal disposable income measures household mortgage debt–service ratios (*DS*). The level of unwithdrawn equity (*UNW*) is calculated by the difference between the current value of the mortgaged housing stock minus the outstanding stock of mortgage lending as a proportion of the stock of mortgage lending

$$UNW = \frac{(M \times MAHP) - OSML}{OSML}$$

where, M is the current stock of mortgages (number); *MAHP* is a mix-adjusted house price; and *OSML* is the outstanding stock of mortgage lending (value). The variable MAHP was obtained from Office of the Deputy Prime Minister (ODPM).

Data have also been provided by lenders on mortgage interest rates (*RM*) at which most mortgage business was written. Real personal disposable income (*RPDI*) data are from the ONS.

5. Methodology

The methodology used in this article pursues the following structure: initially, we examine whether the variables investigated have one or more unit roots; we specify the VAR order and determine the number of cointegrating vectors. Finally, we present a dynamic model of mortgage arrears, based on the long-run determinants of mortgage arrears.

5.1 Unit Roots Tests

We primarily investigate whether the variables described above are stationary or whether they have one or more unit roots. We use three tests to look at the dynamic structure of the time-series: the augmented Dickey–Fuller test (ADF),[14] the Phillips–Perron test (PP)[15] and a test by Im *et al.* (1997) which uses panel data.

The main difference between the first two tests lies in the fact that Phillips and Perron carry out a non-parametric correction to the ADF statistics. However, the critical values for this test are the same as those for the ADF test (Pesaran and Pesaran, 1997). The variables are presented both in levels and in differences. The statistics presented regarding the order of augmentation of the Dickey–Fuller test are based on the Akaike information criterion (AIC) and correspond to an alternative adjusted form of R^2, with a different trade-off between goodness-of-fit and parsimony (Kennedy, 1998). The AIC minimises $\ln(SSE/t) + 2k/t$, where *ln* is the natural logarithm, *SSE* is the error sum of squares, t is time and k represents the number of explanatory variables.

A way to examine whether the series as a whole is stationary (which many researchers claim to be more relevant) is the one developed by Im *et al.* (1997). While the ADF test is regarded as considerably more powerful than other unit root tests, its power decreases with smaller samples for the alternative hypothesis H_1: $\delta = \delta_0 < 1$, when δ_0 is near unity. This does not seem to be a problem in the case of the Im, Pesaran and Shin (IPS) test because it uses panel data, as well as with the fact that a large number of observations is present. Moreover, the simple ADF test regards the size–power trade-off as dependent on the order of augmentation. This again does not constitute a problem in the IPS test.

The IPS test is based on the average of the individual unit root t-statistics and, in its most generalised version, which accounts for possible serial correlation between the disturbances in the Dickey–Fuller regressions, it takes the following form

$$\Psi_{\bar{t}} = \frac{\sqrt{N}\{\bar{t}_{NT}(p, \rho) - 1/N \sum_{i=1}^{N} E[t_{iT}(p_i, 0)|\beta_i = 0]\}}{\sqrt{1/N \sum_{i=1}^{N} Var[t_{iT}(p_i, 0)|\beta_i = 0]}} \quad (8)$$

where,

$$\bar{t}_{NT}(p, \rho) = \frac{1}{N}\sum_{i=1}^{N} t_{iT}(p_i, \rho_i)$$

and $t_{iT}(p_i, \rho_i)$ corresponds to the individual t statistic for testing $\beta_i = 0$ in the following ADF (p_i) regressions

$$\Delta y_{it} = \alpha_i + \beta_i y_{i,t-1} + \sum_{j=1}^{p_i} \rho_{ij}\Delta y_{i,t-j} + \varepsilon_{it} \quad (9)$$

where $i = 1, \ldots, N$; $t = 1, \ldots, T$.

The values of $E[t_{iT}(p_i,0)|\beta_i = 0]$ and $Var[t_{iT}(p_i,0)|\beta_i = 0]$ are reported in Im *et al.* (1997), evaluated via stochastic simulations.

5.2 Lag Specification

In order to implement the Johansen maximum likelihood approach to test for cointegration, a general (unrestricted) vector autoregressive (VAR) model is formulated. This summarily consists of regressing each variable in the model on all the other variables, lagged a number of times—i.e. we allow the time-path of one variable to be affected by current and past realisations of some other variable's sequence and *vice versa*. The number of lags in the VAR system is then specified, based on the Akaike information criterion (AIC).

5.3 Cointegration Tests

Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1992) have developed a methodology centred on cointegration. The technique of cointegration evolves around the idea that certain variables "should not diverge from each other by too great an extent, at least in the long run" (Granger, 1991, p. 65). In other words, although the variables are non-stationary, they can be combined together into a single series which is itself stationary.

There are currently two main approaches to the problem of testing for cointegration: one is referred to as the residual-based approach and is based on the augmented Dickey–Fuller (ADF) test of cointegration; the other is Johansen's maximum likelihood approach. The latter is employed in this paper as it appears to be more reliable and efficient, especially when more than two I(1) variables are involved, as is the case of the present study. It specifically provides a framework to test for cointegration within the context of a vector autoregressive (VAR) error correction model.

The Johansen maximum likelihood procedure is based on a process of n I(1) variables in an $(n \times 1)$ vector X as an unrestricted regression

$$X_t = A_1 X_{t-1} + A_2 X_{t-2} + \cdots + A_p X_{t-p} + \varepsilon_t \quad (10)$$

where, $t = 1, 2, \ldots, T$; p represents the number of time lags and ε_t is an independently and identically distributed n-dimensional vector with zero mean and variance matrix $\sum_{\varepsilon}$. In addition, A is a $(n \times n)$ matrix of parameters. Equation (10) can then be rearranged as follows

$$\Delta X_t = \sum_{i=1}^{p-1} \pi_i \Delta X_{t-i} + \pi X_{t-p} + \varepsilon_t \quad (11)$$

where,

$$\pi = -\left(I - \sum_{i=1}^{p} A_i\right)$$

and

$$\pi_i = -\left(I - \sum_{j=1}^{i} A_j\right)$$

I is the identity matrix. The rank of π is equal to the number of independent cointegrating vectors (r) which exist between the variables in X. It can be obtained by testing for the number of characteristic roots of π that are significantly different from 1. Johansen (1988) demonstrates that this can be

conducted, using two test statistics

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i) \tag{12}$$

$$\lambda_{\max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{13}$$

where $\hat{\lambda}_i$ are eigenvalues and T is the number of usable observations.

Johansen (1988) and Johansen and Juselius (1990, 1992) provide the critical values of both statistics, which have been generated, using simulation studies.

Once we have the number of cointegrating vectors, we then obtain estimates of the cointegrating coefficients (together with their asymptotic standard errors), which show the long-run relationships between the variables considered. Because, at this stage, we will have proved that the variables involved in this process are cointegrated, the deviations of the dependent variable (in this case, the ratio of arrears over 3 months and outstanding mortgages – $ARRM_t$) from its long-run path $ARRM_t^*$ are stationary.

5.4 A Dynamic Model of Mortgage Arrears

The next step is to develop a model in first differences which incorporates an error correction mechanism (ECM)

$$\Delta y_t = \sum_{i=1}^{n} \beta_i \Delta x_{it} + \gamma \left(y_{t-1} - \sum_{i=1}^{n} \alpha_i \cdot x_{i,t-1} \right) + \varepsilon_t \tag{14}$$

where, y is the dependent variable (ARR/M); x represents each of the explanatory variables; β and γ are the coefficients of the explanatory variables in the equation; α is the estimated coefficient of each of the independent variables in the long-run relationship; ε is the error term of the equation, i represents the number of explanatory variables in the model; and t is the time-period.

Therefore, the estimation of a spurious regression because of the presence of possible stochastic or deterministic trends in the data is not a possibility. The model presented above is composed of a long-run solution and has an $ECM(y_t - y_t^*)$ when its coefficient γ is negative.

6. Empirical Results

In this section, we present the estimated results, based on the model set out above, as well as the different steps which constitute the methodology of this study.

Table 1 reports the results of unit root tests, developed by Dickey and Fuller and Phillips and Perron, on the levels and first differences of all the variables incorporated in the analysis. Note that all the variables are in natural logarithms. The results indicate that all the variables are integrated of degree one—i.e. they are stationary when in first differences. The only exception is the debt service ratio (DS) which, according to the Phillips–Perron test, appears to be stationary in levels.

Therefore, it is important to look at all the variables as a dataset *per se* and determine whether the panel is stationary or whether it has a unit root. The results of the IPS $\Psi_{\bar{t}}$ test is -18.8812, which is significantly above the critical value of -2.27 (in absolute terms) at a 99 per cent confidence level.[16] Indeed, the test statistic provides evidence that the series as a whole is stationary when the variables are in differences. Due to this fact, it is highly probable that the variables are cointegrated with each other.

The next step is to decide on the appropriate number of lags to be considered for all equations in the VAR. According to AIC and SBC, the order of the unrestricted VAR is equal to two.

Based on the results obtained above, cointegration tests are conducted in a multivariate framework. The results are reported in Table 2. The trace and maximal eigenvalue tests provided similar results; they reveal that cointegration is supported among the group of variables considered.

Taking the above results into consideration, what follows is the respective cointegrating

Table 1. Unit root tests

Variables	ADF test		PP test	
	Levels	Differences	Levels	Differences
lnARRM	−1.3305	−9.6494**	−1.1728	−29.2557**
ln*UR*	−0.1949	−7.7904**	0.0532	−7.1000**
ln*RPDI*	−0.8382	−7.1535**	0.7320	−9.2687**
ln*LY*	−2.0442	−8.2056**	−2.2073	−11.3818**
ln*UNW*	−1.1742	−9.0296**	−1.2785	−74.5768**
ln*DS*	−2.3019	−6.5044**	−3.9169**	—
ln*RM*	−2.7368	−5.5007**	−1.6888	−5.7246**

**Statistically significant at the 95 per cent level of confidence (95 per cent critical value for ADF and PP statistic = −2.8963).

vector. This shows the long-run relationship between the ratio of arrears of more than 3 months to the number of outstanding mortgages (the dependent variable) and the explanatory variables—see Table 3.

The estimated results imply that the probability of arrears is a positive function of unemployment, the loan–income ratio for first-time buyers and the debt–service ratio and a negative function of unwithdrawn equity.

The long-run relationship between arrears and unemployment is as we might expect and confirms the findings of a number of previous studies. Furthermore, the behaviour of the *LY* and *DS* variables is also consistent with our *a priori* expectation that an increased loan–income value for first-time buyers and/or debt–service ratios increase observed arrears. The role of unwithdrawn equity as a long-run explanatory variable of arrears has not been examined in previous research on UK mortgage arrears. We have specifically addressed this variable here and our long-run equation suggests that an increase in unwithdrawn equity has a relatively large impact in reducing arrears.[17]

The resulting dynamic equation based on this cointegrating vector is shown in Table 4. It is obtained by ordinary least squares. The equation fits the data reasonably well. In addition to a significant cointegrating vector at the 1 per cent level of confidence, the equation includes growth terms in the

Table 2. Multivariate cointegration tests

ln*ARRM*, ln*UR*, ln*RPDI*, ln*LY*, ln*UNW*, ln*DS* and ln*RM*			
Hypothesis		Test statistic (95 per cent critical value)	
Null	Alternative	Eigenvalue test	Trace test
$r = 0$	$r = 1$	54.3569 (39.83)	105.5291 (95.87)
$r \leq 1$	$r = 2$	20.8347 (39.83)	51.1722 (70.49)

Notes: Period = 94 observations from 1993M7 to 2001M4; order of variance = 2.

Table 3. Cointegrating vector, May 1993–April 2001

Explanatory variables	Coefficient	Standard error
Unemployment rate (ln*UR*)	1.6735	0.1371
Real personal disposable income (ln*RPDI*)	—	—
Loan–income ratio for first-time buyers (ln*LY*)	0.4103	0.1897
Unwithdrawn equity (ln*UNW*)	−1.021	0.1323
Debt–service ratio (ln*DS*)	0.6359	0.0907
Mortgage rate (ln*RM*)	—	—

Table 4. Dynamic model of mortgage arrears

Explanatory variables	Coefficient	Standard error [*t*-statistic]
Constant	0.0606	0.0207 [2.9228]***
$\Delta \ln UR$	0.2650	0.0862 [3.0742]***
$\Delta \ln RPDI$	−0.4649	0.3784 [−1.2286]
$\Delta \ln LY_{t-1}$	—	—
$\Delta \ln UNW$	0.0333	0.0185 [1.8000]*
$\Delta \ln DS_{t-1}$	—	—
$\Delta \ln RM_{t-1}$	0.2828	0.1102 [2.5662]***
ecm_{t-1}	−0.0169	0.0049 [−3.4490]***
SSMPI	−0.0089	0.0059 [−1.5085]
Summary statistics		
R^2	0.9577	
Standard error	0.0201	
Durbin–Watson (DW)	2.0443	
Normality	1.9857	
Heteroescedasticity	0.7685	

*Statistically significant at the 10 per cent level of confidence; ***statistically significant at the 1 per cent level of confidence.

unemployment rate, real disposable income, unwithdrawn equity and the mortgage rate. We have also included a dummy variable in order to capture the combined effect of changes to social security entitlement and increases in mortgage protection insurance (denoted SSMPI). As can be seen from Table 4, our estimate of the short-run relationship suggests that changes in *UNW, RM* and *UR* explain short-run movements in arrears. The coefficient of changes in *RPDI* is negative as expected, however, it is not significant at the 10 per cent level of significance. Finally, changes in *SSMPI* that took place in 1995 proved statistically insignificant in the explanation of the dynamics of arrears.[18]

The estimated equation has a high R^2 and the *t*-statistics and remaining diagnostic statistics are robust which shows that the estimates presented are efficient.

7. Conclusions

This paper examines the factors which have driven the reduction in mortgage arrears in the period 1993–2001 for England and Wales. By using cointegration techniques, the results confirm the primacy of unemployment rates and unwithdrawn equity as explanatory variables of mortgage arrears.

In the long run, the loan–income ratio for first-time buyers and the debt–service ratio are also consistent with the existing literature and affect mortgage arrears positively. However, they do not have an effect on arrears in the short run.

In a departure from previous studies, unwithdrawn housing equity exhibits significant explanatory power. The importance of unwithdrawn equity, not surprisingly, appears to be a long-run rather than a short-run phenomenon, suggesting that the existence of unwithdrawn equity significantly reduces the extent of housing arrears. Three main reasons seem to underpin this result. First, unwithdrawn housing equity is acting as a proxy for a buoyant housing market and, in a booming housing market, we would expect mortgage arrears to be lower. Secondly, if the individual or household has a certain amount of unwithdrawn equity, he/she has the option available to sell the property and trade down. Thirdly, unwithdrawn equity may be used when remortgaging the property, in order to avoid going into arrears. These results may suggest that mechanisms should be put in place to promote the use of index-based futures and options in real estate in England and Wales, as suggested by Case *et al.* (1995) following their investigation of the US housing market.

The findings consider the housing market in England and Wales as a whole. This study does not allow for regional variations, as this needs much fuller investigation than has been possible in the paper. Therefore, further research could usefully build on the findings presented above and focus on the regional dimension of the national housing market with respect to the causes of mortgage

arrears, as well as the differences from region to region.

Notes

1. As described by Ford (1997), during the 1980s, many borrowers lost their property as a result of mortgage arrears and, ultimately, possession of their property, which led to a significant increase in homelessness.
2. Since 1979, the dominant housing policy was the promotion of owner-occupation and, consequently, the national housing stock owned by local authorities was reduced dramatically (Atkinson *et al.*, 1987).
3. Nigel Lawson was the Chancellor of the Exchequer from June 1983 until October 1989.
4. The 'Lawson boom' is associated with the peak of the financial system's expansion during the 1980s, which was reflected in an unsustainable credit expansion and inflation of house prices.
5. These changes were motivated by the need to increase tax revenue which was lost by the changes in welfare entitlement (Devereux and Lanot, 2003) and the fact that the expenditure was distorted towards higher-income households, as suggested by Hendershott *et al.* (2002).
6. For more information on the 1995 changes in the social security and the MPPI policies, see Kemp and Pryce (2002).
7. The 1986 Building Societies Act widened the powers of these financial institutions and, as a consequence, they started diversifying their activities and competing openly with banks on interest rates.
8. The deductibility of home mortgage interest for tax purposes has been examined by Woodward and Weicher (1989) and Follain and Malamed (1998).
9. This paper deals with monthly data for England and Wales on mortgages and mortgage arrears and not with microeconomic information on individual borrowers.
10. Stein (1995) argues that, in the case of the US, owner-occupied homes represent the equivalent of approximately 27 per cent of household net worth. As a result, he states that "an exogenous shock to house prices can have a large and broad based impact on household liquidity" (Stein, 1995, p. 381).
11. Even though the study of regional effects in the UK housing market is not the purpose of this paper, the level of arrears as a percentage of total mortgages does not seem to vary considerably across the various regions of the UK. Mortgages which are at least 3 months in arrears constitute approximately 1–3 per cent of the total amount of mortgages across the 12 regions in the UK.
12. We thank anonymous referees for their useful comments on the differences between the housing market in Scotland and the rest of the UK.
13. It should be noted that the dataset used here does not allow us to distinguish between repayment and endowment mortgages. However, it is important to note that the amount of endowment mortgages has decreased from around 60 per cent of the total amount of mortgages in 1993/94 to 5 per cent in 2002, as a result of the benefit changes in 1995. According to Devereux and Lanot (2003), following the changes in tax relief, the gap in costs between repayment and endowment mortgages narrowed and therefore the additional risk associated with endowment mortgages made this type of mortgage increasingly unattractive to borrowers.
14. For a thorough explanation of this test, see Fuller (1976).
15. This test is described thoroughly in Perron (1988).
16. See previous section on testing for unit roots in panel data.
17. Data on consumer credit were used in the initial equation which models mortgage arrears but consumer credit proved to be insignificant as an explanatory variable and was therefore not included in the final set of results. These results are available from the authors, at the reader's request.
18. We have tested for collinearity between ln*UNW*, ln*LY* and ln*DS* using two different methods: correlation matrix and regression of each of these variables on the other two. Both methods showed that the three variables above are not collinear. The correlation between ln*UNW* and ln*LY* is 0.43, 0.15 between ln*UNW* and ln*DS* and −0.45 between ln*LY* and ln*DS*. The R^2 of each of the three equations is 0.33 for ln*UNW*, 0.40 for ln*LY* and 0.04 for ln*DS*.

References

AOKI, K., PROUDMAN, J. and VLIEGHE, G. (2001) Why house prices matter, *Bank of England Quarterly Bulletin*, pp. 460–468.

ATKINSON, A., HILLS, J. and GRAND, J. LE (1987) The welfare state, in: R. DORNBUSCH and R. LAYARD (Eds) *The Performance of the British Economy*, pp. 211–252. Oxford: Oxford University Press.

BÖHEIM, R. and TAYLOR, M. P. (1999) *Unemployment duration and exit states in Britain.* Discussion Papers of the Institute for Labour Research, No. 00/50, University of Essex.

BREEDON, F. J. and JOYCE, M. A. S. (1993) *House prices, arrears and possessions: a three equation model for the UK.* Bank of England working paper.

BROOKES, M, DICKS, M and PRADHAN, M. (1991) *An empirical model of mortgage arrears and repossessions. Bank of England* (mimeograph).

BROOKES, M., DICKS, M. and PRADHAN, M. (1994) An empirical model of mortgage arrears and repossessions, *Economic Modelling*, 11(2), pp. 134–144.

CASE, K., SHILLER, R. J. and WEISS, A. N. (1995) *Mortgage default risk and real estate prices: the use of index-based futures and options in real estate.* Working Paper No. 5078, NBER, Cambridge, MA.

COAKLEY, J. and HARRIS, L. (1992) Financial globalisation and deregulation, in: J. MICHIE (Ed.) *The Economic Legacy 1979–1992*, pp. 37–59. London: Academic Press.

COUNCIL OF MORTGAGE LENDERS (1994) Housing finance, No. 24. November. CML, London.

COUNCIL OF MORTGAGE LENDERS (1997) *Statistics on mortgage arrears and possessions.* Press release, January, London.

DEVEREUX, M. P. and LANOT, G. (2003) Measuring tax incidence: an application to mortgage provision in the UK, *Journal of Public Economics*, 87, pp. 1747–1778.

DOLING, J. FORD, J. and STAFFORD, B. (Eds) (1988) *The Property Owing Democracy.* Aldershot: Avebury.

ENGLE, R. F. and GRANGER, C. W. J. (1987) Cointegration and error correction: representation, estimation and testing, *Econometrica*, 55(2), pp. 251–276.

FOLLAIN, J. R. and MELAMED, L. S. (1998) The false messiah of tax policy: what elimination of the home mortgage interest deduction promises and a careful look at what it delivers, *Journal of Housing Research*, 9, pp. 179–199.

FORD, J. (1997) Mortgage arrears, mortgage possessions and homelessness, in: R. BURROWS, N. PLEACE and D. QUILGARS (Eds) *Homelessness and Social Policy*, pp. 88–108. London: Routledge.

FORD, J. (1993) Mortgage possession, *Housing Studies*, 8(4), pp. 227–240.

FORD, J. and BURROWS, R. (1998) The costs of unsustainable home ownership in Britain, *Journal of Social Policy*, 28, pp. 305–330.

FORD, J., KEMPSON, E. and WILSON, M. (1995) *Mortgage Arrears and Possessions: Perspectives from Borrowers, Lenders and the Courts.* London: HMSO.

FULLER, W. (1976) *Introduction to Statistical Time Series.* New York: John Wiley and Sons.

GRANGER, C. W. J. (1991) Developments in the study of cointegrated variables, in: R. F. ENGLE and C. W. J. GRANGER (Eds) *Long-run Economic Relationships: Readings in Cointegration*, pp. 65–80. Oxford: Oxford University Press.

HARRINGTON, R. L. (1996) Money and finance, in: M. J. ARTIS, (Ed.) *The UK Economy*, pp. 155–193. Oxford: Oxford University Press.

HENDERSHOTT, P. H., PRYCE, G. and WHITE, M. (2002) *Household leverage and the deductibility of home mortgage interest: evidence from UK house purchasers.* Working Paper No. 9207, NBER, Cambridge, MA.

IM, K. S., PESARAN, M. H. and SHIN, Y. (1997) *Testing for unit roots in heterogeneous panels*, Working Paper No. 9526 (revised version), DAE, University of Cambridge.

JACKSON, J. R. and KASERMAN, D. L. (1980) Default risk on home mortgage loans: a test of competing hypotheses, *Journal of Risk and Insurance*, 4, pp. 678–690.

JOHANSEN, S. (1988) Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control*, 12, pp. 231–254.

JOHANSEN, S. and JUSELIUS, K. (1990) Maximum likelihood estimation and interference on cointegration—with applications to the demand for money, *Oxford Bulletin of Economics and Statistics*, 52(2), pp. 169–210.

JOHANSEN, S. and JUSELIUS, K. (1992) Testing structural hypotheses in a multivariate cointegration analysis of the PPP and the UIP for UK, *Journal of Econometrics*, 53, pp. 211–244.

KEMP, P. A. and PRYCE, G. (2002) *Evaluating the Mortgage Safety Net.* London: Council of Mortgage Lenders Research.

KENNEDY, P. (1998) *A Guide to Econometrics*, 4th edn. Oxford: Blackwell Publishers.

MACLENNAN, D. and GIBB, K. (1993) *Housing Finance and Subsidies in Britain.* Aldershot: Avebury.

MALPASS, P. and MURIE, A. (1999) *Housing Policy and Practice*, 5th edn. London: Macmillan.

MICHIE, J. and WILKINSON, F. (1992) Inflation policy and the restructuring of labour markets, in: J. MICHIE (Ed.) *The Economic Legacy 1979–1992*, pp. 195–217. London: Academic Press.

MILES, D. (1993) House prices, personal sector wealth and consumption: some conceptual and empirical issues, *Manchester School*, Supplement LXI, pp. 35–39.

MOORE, B. (1992) Taking on the inner cities, in: J. MICHIE (Ed.) *The Economic Legacy 1979–1992*, pp. 155–157. London: Academic Press.

NETTLETON, S. and BURROWS, R. (1998) Home ownership and health in the United Kingdom, in: A. PETERSEN and C. WADDELL (Eds) *Health Matters*, pp. 308–319. Sydney: Unwin Hyman.

OFFICE FOR NATIONAL STATISTICS (various years) *Regional Trends.* (London: ONS).

ORTALO-MAGNÉ, F. and RADY, S. (1999) Boom in, bust out: young households and the housing price cycle, *European Economic Review*, 43, pp. 755–766.

PAIN, N. and WESTAWAY, P. (1997) Modelling structural change in the UK housing market: a comparison of alternative house price models, *Economic Modelling*, 14, pp. 587–610.

PERRON, P. (1988) Trends and random walks in macroeconomic time series, *Journal of Economic Dynamics and Control*, 12, pp. 297–332.

PESARAN, M. H. and PESARAN, B. (1997) *Working with Microfit 4.0: Interactive Econometric Analysis.* Oxford: Oxford University Press.

STEIN, J. C. (1995) Prices and trading volume in the housing market: a model with down-payment effects, *Quarterly Journal of Economics*, 110, pp. 379–406.

WADHWANI, S. (1986) Inflation, bankruptcy, default premia and the stock market, *Economic Journal*, 96(381), pp. 120–138.

WILLIAMS, A. O., BERANEK, W. and KENKEL, J. (1974) Default risk in urban mortgages: a Pittsburgh prototype analysis, *American Real Estate and Urban Economics Association Journal*, 2, pp. 101–112.

WOODWARD, S. E. and WEICHER, J. C. (1989) Goring the wrong ox: a defense of the mortgage interest deduction, *National Tax Journal*, 42, pp. 301–313.