An empirical model of household arrears

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Abstract

Household arrears on payment obligations are one of the most direct measures of household sector financial stress. This paper uses a time series approach to model two of the key components of aggregate UK household arrears: those on mortgages and credit cards. Mortgages are the main component of secured borrowing by households and credit cards are a key element in unsecured borrowing. Recent data show that both secured and unsecured debt have risen substantially, both absolutely and as a proportion of income since 1997. Unsecured debt has increased more rapidly over this period and so has become more important in overall household debt. During this period of rapid debt accumulation, the proportion of mortgage loans in arrears has fallen but the value of credit card arrears relative to the value of active card balances has risen. The paper explains these differences in the behaviour of arrears by reference to the underlying driving forces identified in previous empirical work. In particular the level of housing equity appears to be more important in explaining mortgage arrears, and the role of supply factors is highlighted for credit card arrears. Although the estimated models confirm that both income and interest repayments (and therefore income gearing) are important factors in explaining both forms of arrears, unemployment only plays an additional role for mortgage arrears. Joint testing of the two models suggests a role for the ratio of the value of the mortgage loan to the value of housing equity for both kinds of arrears, but with opposing effects. In the case of mortgage arrears this might reflect the lenders' perceptions of the quality of the borrower. Credit card arrears appear to contain some information about future mortgage arrears although the reverse does not hold. Both equations adjust relatively quickly to any shocks, typically in around two years. The significance of the income-gearing term for both types of arrears underlines the importance of the path of interest rates for the financial position of the UK household sector.

Summary

There has been a rapid build-up of debt by UK households since the second half of the 1990s, as occurred also in the late 1980s. The ratio of total household debt to disposable income rose to 120% in 2002 Q2, some 10 percentage points above the previous peak in the early 1990s. Unsecured debt has increased from around 16% of total debt in 1990 to around 20% in 2002. A large part of the increase in unsecured debt has been due to growth in credit card borrowing. Despite the growth in both secured and unsecured debt there has been a contrasting difference in the build-up of arrears on different types of borrowing. Credit card arrears of three months have been rising since 1996 but, in contrast, mortgage arrears of six months or more have fallen continuously since 1992.

This paper attempts to explain these differences in the pattern of arrears in terms of the factors accounting for the probability of default on secured and unsecured household loans, and the factors influencing supply of the two types of loans.

Much of the literature uses one of two alternative theories of default to determine the likelihood of going into arrears on a mortgage. The 'equity' theory of default holds that, when households default, they choose to do so voluntarily after a rational analysis of all future costs and benefits associated with continuing or not continuing to meet the obligations of the mortgage. The 'ability-to-pay' theory of default suggests individuals default involuntarily when they are unable to meet current payments. The latter suggests a greater role for flow measures of mortgage repayments. However, the ability-to-pay model can equally be seen as a special case of the equity model where liquidity constraints operate. In general, the literature emphasises the complexity of decisions of borrowers and lenders. There is also a distinction between default and going into arrears. Being in arrears does not necessarily imply an inability to repay debt. All these considerations make it difficult to generate aggregate testable models. Although the empirical analysis in this paper gives some insights into the main influences on arrears, the empirical estimates are essentially reduced-form.

Our empirical model of mortgage arrears provides broad support to the 'ability-to-pay' theory, with mortgage income gearing the most significant explanatory variable. Other significant variables include the unemployment rate, the amount of undrawn equity and the loan to value ratio (LTV) for first-time buyers. Interestingly, the empirical model suggests that mortgage arrears are negatively linked to the loan to value ratio. One possible explanation for this put forward is the effect of second mortgages, which are typically at lower loan to value ratios but tend to be higher-risk. Alternatively, it could reflect supply-side behaviour by banks, given that they are more prepared to extend higher loan to value ratios to better credit risks.

There has been relatively little previous work on explaining credit card arrears in aggregate, although there has been extensive work on credit-scoring techniques applied to individual borrowers. Most of the work originates in the United States, using the Survey of Consumer Finances. This is used to identify characteristics associated with more risky borrowers. Other relevant factors include card usage statistics, which provide an insight into the way in which more

risky customers use their cards. Time series models are also available but these have tended to look at defaults rather than arrears. There is evidence, however, that defaults and arrears have moved together.

As for mortgage arrears, the model of credit card arrears is reduced-form rather than derived from an underlying theoretical structure. Availability of data also limits the scope of the empirical analysis. However, the results indicate a strong positive relationship between credit card arrears and household income gearing. In addition, the growth of credit cards is found to be a significant factor, underlining the importance of increased credit card penetration in the United Kingdom in recent years. Unlike the mortgage arrears model, the research does not find a significant effect for unemployment in explaining credit card arrears. Joint tests of the two equations support these findings although a role for the loan to value ratio is found in explaining credit card arrears but with the opposite sign to that for mortgage arrears. A possible explanation for the opposing signs is that higher LTVs are associated with a better credit risk on mortgage loans, but they might also suggest that households are more likely to be overextended and therefore will build up arrears on credit card debt.

The paper also considers the speed of adjustment within each of the two models. Credit card arrears are found to respond more rapidly than mortgage arrears to shocks from the two equations estimated independently, consistent with anecdotal evidence that individuals tend to default on unsecured debt before secured debt. But when they are considered jointly we find that credit card arrears are a leading indicator of future mortgage arrears. Once this link is taken into account, the underlying speed of adjustment across the two models is found to be very similar.

These equations can be integrated into an overall macroeconomic framework to aid projections of arrears conditional on the macroeconomic environment, and hence permit an analysis of the financial position of UK households.

At the aggregate level, further work might seek to link household sector mortgage arrears to mortgage repossessions and credit card write-offs, and thereby analyse the implications of changes in arrears for the financial position of UK banks. More complete models of the stock-flow relationship of arrears at different durations might improve our understanding of the dynamics between macroeconomic factors and household financial distress. At the disaggregated level, research might usefully consider survey and panel-based sources of data, such as the British Household Panel Survey, to identify those households with a higher risk of default and their characteristics. At the household level, it is likely that changes in individual family financial circumstances (family formation, separation) may be at least as important as aggregate macroeconomic factors.

1 Introduction

The debt-to-income ratio for the household sector was around 120% in 2002 Q2, the highest level since 1987. But, based on aggregate data, the current low level of interest rates seems to imply that households are managing to meet their debt commitments with greater ease than in the early 1990s. Household debt obligations were 7.2% of disposable income in 2002 Q2, compared to an average of 9.6% since the beginning of 1987.[1] One interesting issue for the household sector, therefore, is the extent to which a potential rise in interest rates would make it difficult for households to meet their commitments, thereby forcing them to go into arrears.

This paper attempts to identify models for both mortgage and credit card arrears,[2] in order to understand how arrears relate to key macroeconomic and other variables. Secured debt accounts for around 80% of household debt, but unsecured debt tends to have shorter maturity and its share of debt understates its importance in debt service. Identifying the potential aggregate causes of arrears and, more importantly, the potential impact of any shock, will help us better understand the current risks to the financial position of the household sector.

Section 2 of this paper compares the previous literature on household defaults and arrears. Section 3 applies some of the key insights from this discussion to the development of empirical models for mortgage arrears of more than six months and credit card arrears of three months. Section 4 compares the results from these two models and carries out some joint testing, while the final section of the paper presents possible directions for future work.

2 Background

The proportion of mortgage loans in arrears of more than six months peaked at 3.6% in December 1992[3](Chart 1). This compares to an average of 1.6% from 1986 to 2000. The strong housing market in the late 1980s had led many households to extend their borrowing, and household sector secured lending relative to disposable income rose to a peak of 78.6% in 1990 Q4. The subsequent rise in interest rates caused many households to experience problems in servicing mortgage debt and the associated correction in house prices meant that they faced negative equity and difficulties in refinancing their mortgage.

The mortgage market has again more recently witnessed relatively strong growth in secured lending, with a twelve-month growth rate of just over 13% in December 2002, still below the

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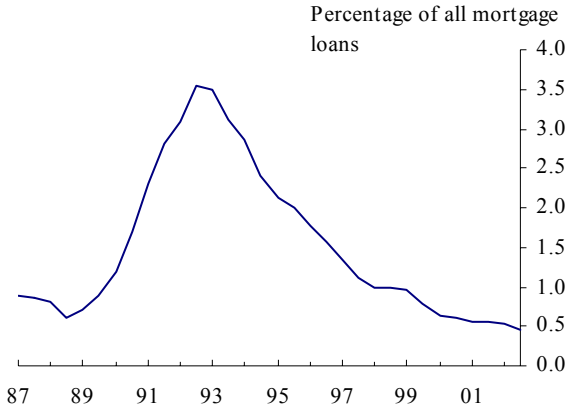
[1] Note that this measure excludes regular principal repayments. For a discussion of the effect of including these and other elements of principal see *Financial Stability Review*, June 2002, page 82.

[2] Due to a lack of data on arrears on unsecured loans, we focus solely on the credit cards component. Credit cards accounted for 30% of total unsecured debt in 2002 Q1, up from 14.4% in 1989 Q3.

[3] Data on arrears of 3-6 months are only available since December 1993.

rates of the late 1980s but high in comparison to the 1990s. Household secured lending relative to post-tax income has increased further to 89.1% in 2002 Q3. But mortgage arrears have been falling continuously since 1992.

Chart 1: Mortgage arrears of six months or more[(a)]

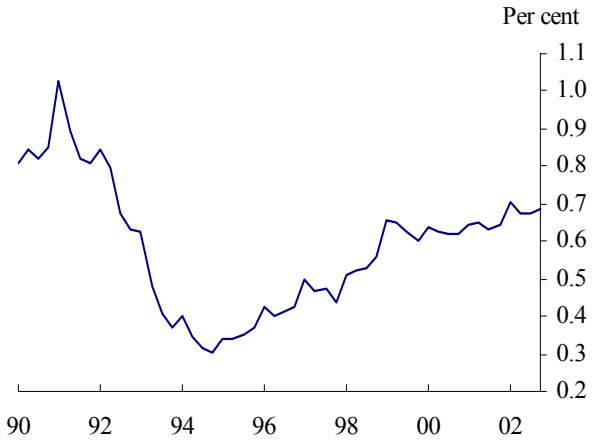


Source: Council of Mortgage Lenders.

(a) As a proportion of the number of loans outstanding.

There has also been a marked expansion in unsecured debt during the 1990s, with unsecured debt as a percentage of income increasing from 11.1% in 1993 Q4 to 21.0% in 2002 Q3. The proportion of unsecured debt accounted for by credit cards has increased from 14.5% in 1990 Q1 to 30% in 2002 Q3. Unlike the experience with mortgage arrears, the rate of credit card arrears has more than doubled since 1995 (Chart 2), although it is still lower than the peak reached in 1991. The use of data on arrears of exactly three months is used as a fairly representative measure of credit card arrears.

Chart 2: Credit card payment arrears of three months[(a)]



Source: APACS.
(a) Value of credit card payment arrears as a per cent of the total value of active credit card balances.

2.1 Previous literature - mortgage arrears

Previous literature on mortgage arrears has focused on two apparently competing views: the 'equity' and the 'ability-to-pay' theories of default. The 'equity' theory holds that borrowers base their default decisions on a rational comparison of the financial costs and returns involved in continuing (or discontinuing) the periodic payments on the mortgage loan obligation; seeking to maximise/minimise the financial gain (loss). This view implies a strict optimising behaviour of mortgage borrowers.

The 'ability-to-pay' theory of default maintains that borrowers do not default provided that their income flow remains sufficient to meet the periodic payment without undue financial burden. This could be regarded as a special case of the 'equity' approach where borrowers are prevented from behaving 'rationally' by liquidity constraints, associated with imperfect credit markets. Faced with an unexpected fall in income or rise in interest rates, they may be unable to extend or renegotiate credit to finance their existing debt service payments. Several commentators have argued that the two approaches are not distinct. Lambrecht, Perraudin and Satchell (LPS) (1997), for example, argued that short-run fluctuations in income might affect defaults even in perfect credit markets. The ability to access credit markets might vary across households, depending upon their projected income stream. For those households whose access to credit markets is important, default will be more costly because this will restrict future access to the markets. LPS also noted that, in the United Kingdom, defaulting does not necessarily wipe out the liability to the mortgage lender, complicating the 'equity' hypothesis. In that spirit the interpretation of the empirical literature should be eclectic.

In one of these empirical exercises, Jackson and Kaserman (1980) used US cross-sectional data of loans that all originated in 1969. They regressed default probability against three variables:

- The contract life of the mortgage obligation from origination to maturity.
- The contract rate of interest on the mortgage obligation.
- The loan-to-value ratio on the mortgage loan at origination.

They found that the contract life and loan-to-value ratio were significant and positively related to the probability of default. The interest rate variable, however, was insignificant, suggesting support for the 'equity' theory of default, since this was the variable most relevant to current cashflow (although the role of income highlighted by LPS was not included in the model). The predictive power of the model, however, was low at just 1%. Jackson and Kaserman argued that this might be explained by the differing coverage of mortgage loan default insurance across households.

The importance of 'equity theory' variables in US studies might be reduced in UK studies because a higher proportion of outstanding UK mortgage loans are variable rate. LPS examine the timing of default in the UK mortgage market using a sample of 5,272 defaults and repossessions over the period 1987-91. The data were drawn from an insurance claim database of a major financial institution, each record reflecting a claim for compensation from a UK building

society. LPS condition on variables observable by the lender at the time that the loan was first granted, rather than *ex-post* variables such as the loan-to-value ratio at the time of default. Their dependent variable is the average time to default, which decreases substantially between 1987-91. The independent variables used in their study were the initial loan-to-value (LTV) ratio, the salary of the borrower, their marital status and the interest rate at which the mortgage was originally granted. They find that the time to default is negatively related to interest rates and positively related to salary. Being married is also associated with a longer time to default but was significant in only two of the five years examined (1987-91). More surprisingly, the LTV ratio was found to be positively associated with time to default. They explained this by the increased use of second mortgages, which had small LTV ratios but a higher probability of default. LPS concluded that 'on balance, 'ability-to-pay' variables appear to affect times to default more than 'equity' variables'.

Other studies attempt to explain arrears. Unlike default, going into arrears does not necessarily imply an inability to repay debt. A study by Coles (1992) used a Council of Mortgage Lenders' (CML) survey into the causes and characteristics of arrears and possessions. The telephone survey of 20 UK lenders took place in December 1991 (a period of sharply rising arrears). Coles concluded that arrears problems were explained by five main factors: 20%-30% of arrears were associated with unemployment; 10% with other income shocks; 5% with business failure; 20%-25% with a relationship breakdown; and 15% with financial mismanagement. Those experiencing difficulty were typically found to be either self-employed, associated with the construction industry, or employed in sales-orientated businesses where a significant proportion of income came from commissions. The study also found that 60% of those in serious arrears (six months or more) still made a regular significant repayment of some sort. A high LTV ratio was frequently noted as the most important characteristic of loans going into arrears. The survey also found that repossessions were instigated after about six months of being in arrears.

Breedon and Joyce (1992) used these findings from the CML survey to select variables for their aggregate analysis using a three-equation model of house prices, arrears and repossessions over the period 1971-91. They found a significant role in explaining arrears for variables reflecting the borrower's short-run financial situation, notably the unemployment rate and the debt-service ratio, but also found that the level of unused housing equity was important.

In a subsequent study, Brookes, Dicks and Pradhan (BDP) (1994) considered 'front-end' loading, where higher expected inflation raised nominal interest rates which, in the absence of indexation, induced higher initial debt service burdens. They showed that it was only unanticipated inflation that affected households' payment difficulties, suggesting that inflation *per se* might not affect the long-run level of arrears/repossessions. Their estimated model implied a long-run relationship between mortgage arrears, debt-service, undrawn equity, the inflow to unemployment, and capital gearing of first-time buyers, where debt-service was the dominant cause of changes in arrears. Changes in the inflow to unemployment were estimated to have sizable effects as well but the effects of increases in net housing wealth operating through the undrawn equity term were found to be fairly small. In all cases the build-up in arrears to a change in any one of these key determining variables was estimated to be very protracted.

Much of this previous literature has a strong basis in empirical features rather than underlying theoretical structure. A full explanation of the factors leading to arrears would need to take account of determinants of the take up of credit by borrowers and the supply of credit by lenders, as well as complex decisions involving risk and uncertainty that might result in arrears. That is beyond the scope of this paper, which seeks to draw out some of the reduced-form regularities in the data.[4] The previous work (particularly using UK data) suggests a number of relevant variables, principally:

- Measures of income gearing
- Unemployment rate
- Level of (undrawn) equity
- Loan-to-value ratios

2.2 Previous literature - credit card arrears

The approach to modelling credit card arrears differs from that of mortgages because of the different characteristics of the two markets for debt. Credit card debt tends to involve much smaller amounts of debt than mortgage debt but although there may be an upper limit to the amount borrowed on any one card, it is possible for an individual to have several cards using different providers. In contrast, mortgage-holding individuals are likely to have no more than two mortgage providers. Debt repayment on credit cards is flexible, with the minimum monthly repayment either being a fixed percentage of the total balance or a nominal amount (often as low as £5). In contrast the mortgage lender agrees a regular repayment schedule with the borrower that typically constitutes both interest and capital repayments. No collateral is required for credit card borrowing, increasing the risk to the lender.

Despite the rapid growth in credit card debt surprisingly little work has been done on credit card arrears and their distribution either at an aggregate or disaggregate level, particularly in the United Kingdom. This partly reflects data availability. None of the major household surveys, including the Family Expenditure Survey, Family Resources Survey, Financial Research Survey, British Household Panel Survey and the General Household Survey contain regular information on the stock of unsecured debt or payment arrears. Most data on unsecured payment arrears are held confidentially by lenders and credit rating agencies. These organisations use the information to develop credit scoring models that evaluate the credit risk of loan or credit card applicants.

Credit scoring techniques estimate the probability of default by looking at the credit history and characteristics of borrowers. As arrears precede default, variables used in credit scoring models may also be important in explaining arrears. Information is collected on individuals when they apply for credit. Typically, in these models a borrower is said to be in default if they miss three consecutive monthly payments. There is an extensive literature on credit scoring methods.

[4] Similar considerations apply to the model for credit card arrears.

Traditionally, linear probability models and discriminant analysis have been used. The former calculates the predicted probability of default for each new applicant. The latter distinguishes between high and low-risk borrowers.

Increasingly sophisticated statistical and mathematical models have also been used, for example options-pricing theory and neural networks. Hand (2001) compares 'current developments in retail banking and the developments in the capital markets that took place 30 years ago. There, the introduction of advanced models of risk management led to dramatic progress and an avalanche of technical development'. There is also a broad range of literature on issues arising from credit scoring such as population drift, sample bias and discouraged borrowers.

Banks and rating agencies do not generally publish the data they hold on individuals or the results of their credit scoring models and only very general information is therefore available. Bridges and Disney (2001) list variables typically found in a credit scoring model of default: an individual's monthly income, outstanding debt, financial assets, type of bank account, time in job, whether the individual has ever defaulted on a previous loan and whether they own or rent a home. A published credit scoring model using Portuguese micro-data found a similar set of significant variables for determining the probability of payments two or more months overdue (Camoes and Hill (2001). But it also included variables proxying the nature of employment (private, public, self-employed, unemployed), the number of children, the number of dependants, marital status, education, number of credit cards, time in present current account and credit card balance. Banasik, Crook and Thomas (1999) found that the extent to which a credit card is used might also affect the probability of default in a credit scoring model. Mester (1997) reported that as many as 50 to 60 variables might be considered when developing a typical model but eight to twelve might end up in the final equation.

Gross and Souleles (2001b) were however able to access a panel of thousands of US individual credit accounts to show that an increase in the credit limit results in a increase in the amount of debt extended. This is rationalised in buffer-stock terms as enabling additional precautionary saving and is found to occur even when individuals simultaneously hold low-yielding assets. Higher levels of debt increase the vulnerability of individuals to unexpected adverse financial developments. In a related paper using similar data (Gross and Souleles (2001a)) they show that personal bankruptcies and delinquency rates rose between 1995-97 because the default costs of bankruptcy fell as the stigma associated with bankruptcy was reduced, rather than as a consequence of high levels of debt.

Most published work on credit card arrears has been based on US data from the Survey of Consumer Finances (SCF). Black and Morgan (1998), for example, looked at credit card arrears of one month or more in 1989 and 1995. They compared individuals who held credit cards in 1989 with those who held credit cards in 1995 but not in 1989; in other words they tried to assess whether 'new' card holders were different and potentially riskier. They then assessed whether the characteristics of these 'new' borrowers increased the probability of credit card default and therefore whether this could partly help to explain the increase in arrears between 1989 and 1995. They used the differences between 'new' and 'old' borrowers to determine what variables might be important in explaining credit card arrears. They found that new borrowers were more likely

to be single, to rent rather than own their own home and to have less seniority in their job. New card holders also tended to earn less and had higher debt-to-income ratios. Their attitude to debt was also different. They appeared more willing to borrow to finance holidays or cover living expenses if income fell. Black and Morgan found that the change in the profile of the average borrower increased the probability of credit card default. The household debt burden, measured as the ratio of debt payments to income, was the main determinant of default risk. If a household had income gearing 1 percentage point above the average level, it was 9.7% more likely to be in payment arrears. Surprisingly they found a positive relationship between income and delinquency risk. Marital status was also important - the default rate among unmarried households was 2% higher than among married households. Employment status also helped to explain default risk - one year less than average in the current job increased default risk by 0.28%. Default rates among blue-collared workers were 3.8% higher than among executives or managers. The probability of default was also increased if the job was in a heavily cyclical sector. Factors that had a negative relationship with the probability of default included liquid assets, age and education.

But as Dunn and Kim (1999) noted 'some critical features of the consumer situation are not available in the SCF'. They argued that the debt-to-income ratio, commonly used in default analysis, only acts as a 'rough proxy' for more detailed strategic consumer behaviour that has become possible as the credit card market has expanded. They used data on credit card usage collected through a monthly household telephone survey that was carried out for a year. Each month between 500-1,200 households were contacted. Dunn and Kim found that the total minimum payment required on a credit card as a per cent of income was a better predictor of default than the total debt-to-income ratio. They argued that this was because debt to income has greater significance for an individual's overall debt position in the long run. In the short term, the ratio of minimum required payment to income is more relevant to the consumer's month-to-month ability to avoid default. They argue that consumers can now use revolving credit to maximise utility subject to the constraint of their monthly minimum payment, rather than their overall income.

Another variable which they found significant in explaining credit card defaults was the percentage of the total credit line the consumer had used. In the short run a decrease in this ratio reduces the probability of default. This is because the consumer has deferred payment and/or the ratio already reflects information that the bank has on the consumer's perceived level of risk. In the long run, however, consumers cannot continually repay old debt with new debt and an increase in the ratio will increase the probability of default. Another significant variable in their analysis was the number of cards on which the consumer had reached the maximum limit. Without a centralised banking system consumers are able to fund some credit card debt with other credit card debt. There will be a limit to the extent a consumer can manage their debt in this way and as the number of maximally used cards increases so does the probability of arrears. As well as incorporating these innovative variables this study also looked at the more 'regular' set of socio-economic explanatory variables. Surprisingly, Dunn and Kim found that education, income and home-ownership, all variables traditionally used in credit-scoring models, were not significant in estimating the probability of default. Their results also suggested the absence of a role for socio-economic characteristics.

The literature discussed so far looked at panel data. There are also time series analyses of credit card debt, but these have tended to focus on credit card write-offs rather than arrears. Despite this, studies in this area are also interesting because debts that have been written off were previously in arrears. There is also evidence that credit card arrears and write-offs rise together. The studies again focus on US data. US credit card write-off data goes back to 1971. From 1971 to 1983 commercial banks wrote off only an average of 2.3% of their credit card loans. Between 1983 and the mid-1990s it averaged 3.8%. In 1996 (when most of these studies were based) it had reached nearly 5%.

Laderman (1996) discussed two reasons why credit card write-offs rose sharply in the United States in the first half of the 1990s. First, the close negative relationship between employment growth and the credit card charge-off ratio since the early 1980s was noted. As economic conditions improve, employment growth accelerates and write-off rates fall as people improve their financial positions. Laderman suggested that small businesses might provide an important link in this relationship. Some small businesses tend to use credit card debt instead of business loans to raise capital. Small businesses also tend to be an important source of employment growth. In addition higher write-off rates might reflect aggressive credit card marketing and credit card growth, resulting in credit being extended to riskier individuals.

There is other evidence to support the hypothesis that faster credit card growth and more intense competition in the credit card industry leads to increased write-offs and arrears. Citicorp estimated that in the second and third years after a big marketing drive, loan write-offs would peak at around 175% above their life-time average (see Hand (2001)). There is also evidence that in conditions of severe competition lenders are willing to work with 'troubled borrowers and give tardy players some leeway' *(American Bankers Association Magazine)*. Morgan and Toll (1997), however, disputed the idea that credit card arrears and write-offs rose as a result of lenders supplying cards to riskier borrowers without correctly pricing in the risk. They examined credit card spreads and found they rose along with credit card write-offs between 1982 and 1997, suggesting that lenders charged for the increased risk. Finding no supply-side arguments, they looked at demand for credit card debt. They found that household net wealth and the proportion of the population at 'peak' borrowing age fuelled the demand for credit and drove up debt burdens between 1983 and 1997.

One key message that comes from the previous literature is the difficulty of capturing supply-side influences. This is particularly acute at the aggregate level. Another problem with the data at an individual level is in measuring the overall amount of credit extended relative to credit limits, especially since borrowers can access credit through multiple use of cards.

As far as we are aware the only time series study of aggregate credit card arrears in the United Kingdom is that by the Association for Payment Clearing Services (APACS) using data collected from their members. The latest model assesses credit card payments that are one or more payments overdue. Significant explanatory variables are arrears lagged by one period, income gearing, and credit card growth.

Variables in the model

The literature discussed above suggests some possible contenders for a time-series aggregate explanation of credit card arrears.

- Income gearing
- Unemployment
- Wealth
- Consumer confidence
- Proxies for the growth of the credit card market, distinguishing between changes in supply and demand factors.

The literature suggests that some similar factors are relevant to both mortgage and credit card arrears at the aggregate level. In particular flow indicators of current financial health, such as unemployment, and income gearing, are common factors identified for both types of arrears. However there are also some differences. Debt or capital gearing measures have been identified as potential factors explaining mortgage arrears but not credit card arrears, whereas supply-side factors proxying the growth of the market might be more likely to be important in explaining credit card arrears.

3 Empirical models

We now turn to the empirical models, beginning with mortgage arrears.

3.1 Mortgage arrears

Annex 1 describes the key variables used in modelling mortgage arrears. These are based on Council of Mortgage Lenders' and ONS data. The sample size was restricted by the availability of data. The Council of Mortgage Lenders (CML) has published data on the proportion of the number of mortgages in arrears on a bi-annual basis since 1982 (previously available annually back to 1969). We interpolate linearly to give quarterly data. The CML puts strong health warnings on the use of their data prior to 1982. Data on other durations of arrears are also available but arrears of six months or more might better reflect the period after which borrowers might be in financial difficulty with the mortgage. Further, data on arrears of less than six months are not available on a reasonably long-run basis. Data on undrawn equity were only available back to 1984 and so the model is estimated on data from 1985 Q1 to 2000 Q4.

The relevant debt service variable might be defined as either total or mortgage income gearing. We use mortgage income gearing because it is the measure of debt service on secured debt. Furthermore, anecdotal evidence suggests that the mortgage is one of the last items on which households default and so it may be misleading to use total income gearing. However it might also be argued that total income gearing determines the totality of arrears, including those on mortgage debt. When including loan-to-value ratios, we also consider both ratios for former owner-occupiers and for first-time buyers. The preferred model uses the ratio for first-time buyers since this group of borrowers are more likely to be the younger 'more vulnerable'

borrowers that are more likely subsequently to default. The sensitivity of the model to this choice is discussed later in this paper.

Inspection of the data in Annex 2 suggests that they are all broadly stationary so that the right hand side variables are capable of explaining the broad variations in the dependent variable over the chosen sample. This is confirmed by order of integration tests, although these have low statistical power. Cointegration tests based on Johansen and Juselius (1992) show one cointegrating vector and this is confirmed by the significance of the *t*-statistic on the ECM term in the estimated equation (Kremers *et al* (1992)). The specification of the model was determined by choosing the relevant variables based on the literature and testing down from general to specific, eliminating insignificant explanatory variables at successive stages.

Dynamics and sensitivity to the measurement of arrears

Before going on to describe the estimation results, we outline the effect on estimation of measuring arrears in excess of six months in the context of a quarterly model. There are two issues here. First, there are the implications arising from measurement of arrears as more than six months. Second, there is the issue of interpolation of half-yearly data into a quarterly series.

The use of mortgage arrears of six months or more as the dependent variable has important implications for the interpretation of the empirical model. Households will already have been in arrears before entering the category of arrears of six months or more. This implies that the model determines whether an individual will be in arrears in period *t*, taking their position in period *t*-1 as a given. It therefore picks up several potential transitional movements:

- those in arrears of three to six months moving into arrears of six months or more;
- those already in arrears of six months remaining in arrears;
- those in arrears of six months moving out of arrears; and
- those in arrears of more than six months moving into a lower level of arrears.

This process can be represented as:

$A(i,t) = 1 \text{ if } bX(i,t) + e(i,t) > 0$
$= 0 \text{ if } bX(i,t) + e(i,t) < 0$

where $A(i,t) = 1$ when a household (i) is in arrears in period t; and is 0 when they are not in arrears, and $X(i,t)$ is a set of determining factors affecting arrears.

Then being in arrears for six months requires
$A(i,t)=A(i,t-1) =A(i,t-2) = 1$

This emphasises that both past and current values of the independent variables will influence arrears. In estimation these lags are captured by the inclusion of lagged arrears. Moreover this simple model shows that there should be a contemporaneous effect of X on arrears.[5] The second issue relates to interpolation. Quarterly data on mortgage arrears was derived from the twice-yearly data by linear interpolation. A quarterly frequency was desired in order to link this model with other models. This might induce biases in the significance of the estimated coefficients as it results in a moving average error process in the model. However the implied long-run elasticities and their statistical significance from the arrears model using a six-monthly model are very similar to the quarterly model suggesting little bias in the results. As an additional check the model was estimated explicitly allowing for a moving-average error process. The plot of the log-likelihood function implied that the moving-average parameter was close to zero.

Estimated results

The version of the model based on a simple error-correction representation using OLS regression was:

$$\Delta \ln A6 = 0.795 - \underset{(-1.3)}{0.0834}(\Delta \ln MIGM) + \underset{(2.1)}{0.0712}(\Delta \ln UR) - \underset{(-2.1)}{0.3934}(\Delta \ln LTVFTB) - \underset{(-3.1)}{0.9160}(\Delta \ln UDEQUITY) + \underset{(5.5)}{0.4307}(\Delta \ln A6)_{-1} - \underset{(-3.2)}{0.1017}(ECM)_{-1}$$

$$ECM = \ln A6 - \underset{(-4.1)}{2.7382}\ln MIGM - \underset{(-4.4)}{0.7000}\ln UR + \underset{(3.0)}{3.866}\ln LTVFTB + \underset{(11.2)}{9.003}\ln UDEQUITY - \underset{(-1.3)}{7.8155}$$

Where t-ratios are shown in brackets; aymptotic for long-run coefficients.
Estimation period: 1985 Q1 – 2000 Q4. $\bar{R}^2 = 0.862$, standard error = 0.032

where *A6* is the CML measure of the proportion of all loans in arrears of six months or more, *MIGM* is the measure of mortgage income gearing, *UR* is the claimant count measure of unemployment, *UDEQUITY* is the measure of the level of undrawn equity (gross housing wealth less mortgage debt expressed as a proportion of housing wealth) and *LTVFTB* is the CML measure of loan-to-value ratios for first-time buyers. Subscripts indicate time lags.

The estimated equation satisfies the priors on expected signs and has a reasonable degree of fit (Annex 2, Charts A2.6 – A2.7). A dynamic forecast test from 2001 Q1 to 2001 Q4 shows no evidence of predictive failure (F(4)=0.9). A rise in mortgage income gearing increases arrears, as does a rise in the unemployment rate. In contrast, a rise in undrawn equity reduces arrears. Aggregate measures of undrawn equity and LTV both capture some form of capital gearing of households on their housing assets, so we might not expect both of them to be statistically

[5] We are grateful to an anonymous referee for this point.

significant in a regression on arrears. This possibility is also noted by Lambrecht, Perraudin and Satchell (1997).

The coefficient on the LTV for *first-time buyers*, however, captures the marginal effect on arrears from capital gearing of first-time buyers. The empirical results support the view that a rise in the loan-to-value ratio for first-time buyers *reduces* the level of arrears, suggesting that the loan-to-value ratio acts as a proxy for the credit quality of new borrowers. LTV may therefore act as an indicator of confidence of lenders whereas the effect of capital values on arrears may be better captured by the undrawn equity term (this remains significant when the LTV term is dropped from the equation).

This rationale is suggestive of possible simultaneity bias, given that arrears depend on, *inter alia,* the loan-to-value ratio, while the latter is itself influenced by arrears as a proxy for credit quality.

Another possible source of simultaneity is between arrears and undrawn equity. High arrears might discourage new mortgage borrowing or lower mortgage equity withdrawal (as a result of either supply-side or demand factors), and hence increase measured undrawn equity, suggesting a positive relationship. Granger causality tests suggest, however, that there is no simultaneity between undrawn equity and arrears (that is undrawn equity drives arrears rather than arrears determine undrawn equity).

The estimated equation is log-linear and the model successfully passes the test for functional form. We also tested a linear equivalent. The linear model had heteroscedasticity problems and two of the variables were insignificant. That suggests a mild form of nonlinearity, but there was nothing in the aggregate data and its sensitivity to functional form that suggested more substantial nonlinearity. The properties of the model can be analysed either in per cent or percentage point terms. The log-linear form implies that a 1% sustained rise in mortgage income gearing will eventually increase the proportion of loans in arrears by just under 3%. A 1% sustained rise in the unemployment rate will ultimately increase the proportion of loans in arrears by around 0.7%. A 1% rise in the level of undrawn housing equity will *lower* the proportion of arrears by 9%, and a 1% rise in the loan-to-value ratio will *reduce* arrears by just under 4%.

In the above example, a 1% rise in mortgage income gearing would increase it from its recent level of 5.2% to 5.25%. The marginal absolute responses will differ depending on the initial levels of the dependent variable (proportion of loans in arrears) as well as those of the respective right-hand variables. Table A presents some sensitivity calculations based on a 1 *percentage point* change to show this, using the mean, maximum or minimum levels of the variables over the sample period. The table shows that a 1 percentage point increase in income gearing can raise the proportion of mortgage loans in arrears by between 0.3 to 2.6 percentage points depending on the initial levels of gearing and arrears. The effect is greatest when arrears are at a high level and gearing at a low level. There is less variation in the implied responses to changes in the other key variables.

Table A
Estimated long-run effects in the mortgage arrears equation[(a)]

Level of independent variable	Level of arrears	*Income gearing*	*Unemploy-ment*	*Undrawn equity*	*LTV-FTB*
Mean	Mean	0.69	0.14	-0.18	-0.07
	Max	1.58	0.32	-0.41	-0.16
	Min	0.27	0.06	-0.07	-0.02
Max	Mean	0.40	0.10	-0.16	-0.06
	Max	0.92	0.22	-0.38	-0.14
	Min	0.16	0.04	-0.06	-0.02
Min	Mean	1.09	0.29	-0.20	-0.07
	Max	2.49	0.67	-0.46	-0.17
	Min	0.44	0.11	-0.08	-0.03

(a) Numbers in the table reflect the percentage point effect on mortgage arrears of a 1 percentage point change in the independent variable at different levels of the dependent and independent variable. The mean of arrears was 1.55%, the maximum 3.55% and the minimum 0.62%.

Alternative specifications of the model

A number of alternative specifications of the model were examined to see if they improved its explanatory power. These alternatives cover different data measures as well as different variables. The first data-related sensitivity we cover is the role of the LTV ratio. In the model we use the ratio for first-time buyers. This is the current (or residual) loan-to-value ratio. The ratio some months earlier might be more relevant since it takes some time for arrears to build up. We estimated the model with different lags on the loan-to-value ratio but these were generally found to be insignificant. The current loan-to-value ratio appears to exert an important influence on arrears via supply-side effects, where lenders may be more prepared to extend a high loan-to-value ratio, the lower the credit risk attached to the borrower.

For most of the shocks some 80%-85% of the final adjustment is completed within two years of the shock, and the adjustment is virtually complete within three years.

We also investigated the 'second mortgage' argument as one of the rationales for a role for the loan-to-value ratio, as set out by Lambrecht, Perraudin and Satchell (1997). This will not be valid for first-time buyers since, by definition, they will not have a second mortgage. We estimated the model with the LTV ratio for all occupiers or just for former owner-occupiers. These variables were found to be marginally insignificant and their inclusion resulted in a weaker and less significant role for the other influences. An alternative specification including LTVs for both first-time buyers and former owner-occupiers found statistically significant coefficients on the variable for first-time buyers but not for former owner-occupiers. This suggests that the 'second mortgage' argument does not have a significant effect within our model, and the presence of the LTV term reflects supply-side considerations.

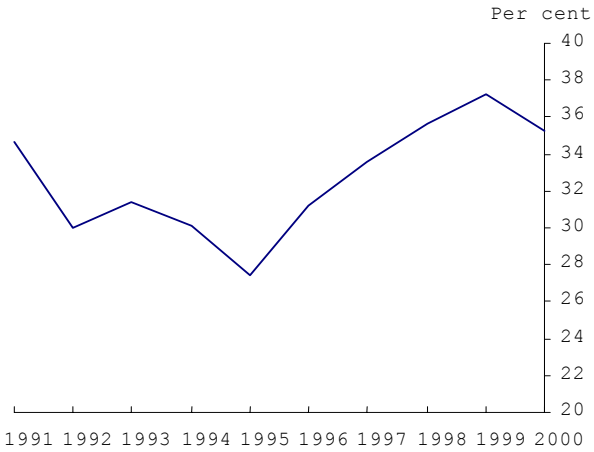
We considered using the employment rate (in contrast to the *un*employment rate used in the preferred model) and additionally the liquidity of the household sector (estimated by liquid assets and by M4 holdings). These were both found to be insignificant and, in the case of the liquidity variable, wrongly signed.

Recent work at the Bank of England has sought to augment measures of UK household income gearing by including principal repayments as well as just the debt interest payments covered in the national accounts measures used in this model.[6] Including regular mortgage principal repayments does not significantly alter the profile of the series over time and so does not change markedly the specification of the model. Including other forms of principal repayment (for example, redemption or lump-sum repayments) produces a different picture of debt service payments but since these are often voluntary payments (including remortgaging) there seems no convincing reason to adopt this variant measure in explaining mortgage arrears. A series including principal repayments on unsecured loans is not available back beyond 1997 and so cannot be included within the model.

A further hypothesis investigated was whether the take-up of mortgage payment protection insurance has a significant effect on the level of arrears. For example, households may not enter arrears when they have payment protection insurance if the insurance will make up the shortfall. Chart 3 shows the proportion of all household heads who have reported their last total monthly mortgage payment who say that their mortgage includes a protection policy. The data are extracted from the British Household Panel Survey on an annual basis from 1991 to 2000. This gives us some idea of the proportion of households with some form of mortgage payment insurance (some households, however, may choose to insure their mortgage policy through an alternative provider). Chart 3 shows that there has been an increase in mortgage payment protection insurance in the second half of the 1990s, from 27.4% in 1995 to 37.2% in 1999. Given that mortgage arrears have been falling constantly since 1992, it does appear that there is a simple link between the two although we did not investigate this further due to the limitations with the data.

[6] See, for example, *Financial Stability Review*, June 2002, page 82.

Chart 3
Use of mortgage payment protection insurance [(a)]



Source: British Household Panel Survey.
(a) Proportion of household heads who have reported their last total monthly Mortgage payment who say their mortgage includes a protection policy.

The recession in the early 1990s bore witness to significant turmoil in the housing market, with a number of people experiencing negative equity. In contrast, the rest of the 1990s has been a relatively benign period. Anecdotal reports suggest that lenders adjusted their practices after the experience of the early 1990s. We therefore tested to see if there was a structural break post-1993 by including a dummy shift variable. However this was insignificant, indicating no structural break. So the major variation in mortgage arrears over this period can be captured by the set of variables identified in the model.

Conclusion

The mortgage arrears model presented here suggests that the main influences on mortgage arrears are mortgage income gearing, the unemployment rate, undrawn equity, and the loan-to-value ratio for first-time buyers. It provides broad support for the 'ability-to-pay' hypothesis, as evidenced by the significance of income gearing. The negative sign on the loan-to-value ratio is consistent with it being used as a screening mechanism by banks to avoid risky customers. The model reacts relatively quickly to any shocks, with 80-85 per cent of any adjustment taking place within two years. A shock to income gearing has the largest effect on arrears.

3.2 Credit card arrears

APACS have collected data on credit card arrears that are one to six payments overdue since January 1990. Short-term credit card arrears are unlikely to be a useful indicator of financial distress as many people may miss payments due to illness, holidays or forgetfulness. Further, due to data collection problems between January 1990 and June 1993, we are unable to define arrears as three or more payments overdue as this would reduce the time period over which we can estimate a model. We therefore use data on cards where there are exactly three payments overdue as a representative measure. These data are available reliably back to 1990. We define arrears as the value of arrears as a per cent of the total value of credit card balances outstanding. The set of potential explanatory variables has been set out above and includes income gearing,

unemployment and the number of active credit card balances. Annex 1 contains details of how all the variables were constructed. Annex 3 contains charts of all the variables.

Unlike the mortgage arrears model some of the variables appear to be trended over the sample period from 1990 to 2002 Q1. The significance of the *t*-statistic on the ECM term suggests cointegrability of the final form (Kremers *et al* (1992)). Seasonal dummy variables were included and a dummy variable was also added for 1991 Q1 where there appears to have been a data collection error. The model, estimated in error correction form was:

$$\Delta A = \underset{(0.02)}{-0.002\Delta YG} + \underset{(6.9)}{0.143(\Delta \ln B)}$$

$$\underset{(-6.2)}{-0.290\ ecm_{-1}}$$

where $ecm = A - \underset{(-9.3)}{0.0695\ YG} - \underset{(-7.8)}{0.492\ LnB} + \underset{(7.8)}{8.673} + \underset{(3.9)}{0.231S2} + \underset{(3.9)}{0.221S3} + \underset{(3.9)}{0.181S4} - \underset{(3.5)}{0.448\ DUM1}$

t-ratios are shown in brackets (asymptotic for long-run coefficients).
Estimation period: 1990 Q3 – 2002 Q1, $R\text{-}bar^2 = 0.805$; standard error =.0248

where *A* is credit card arrears of three months (as a percentage of total credit card balances outstanding), *YG* is total income gearing, *B* is the number of active credit card balances, S2, S3, and S4 are seasonal dummies and D91Q1 is a dummy for 1991 Q1. The number of active credit cards is included in log form whereas all the other variables are linear. This is to capture the exponential growth in credit cards. Subscripts indicate time lags.

The model conforms to prior expectations for the signs of the variables, although significant effects from unemployment, wealth or consumer confidence could not be identified. Increases in income gearing or the number of active credit card balances are predicted to result in an increase in credit card arrears. The number of active credit cards is included as a supply-side proxy. It was used to capture the increased risk from households by Morgan and Toll (1997). Survey evidence suggests that the penetration of credit cards has increased significantly in recent years (Bank of England (2002)). This variable has added power over simple time trends (the coefficient on the time trend is statistically insignificant when both variables are included).

The long-run effects imply that a 1 percentage point rise in income gearing will lead to a 0.07 percentage point rise (10% on the latest observation of arrears) in the percentage of balances in arrears. A sustained 1% increase in the number of active credit card balances will ultimately raise the rate of credit card arrears by 0.0049 percentage points (0.7% on the latest observation).

The speed of adjustment to a permanent shock is the same for the two variables. In each case 70% of the final adjustment has taken place within one year. Full adjustment is virtually complete (97%) within two years. The speed of response to these permanent shocks seems plausible given the relatively rapid dynamics of the credit card market. Predictive failure tests suggest reasonable forecasting performance. The test statistic is not significant when the equation

is estimated on a shorter period to 2001 Q1 and used to forecast from 2001 Q2 to 2002 Q1 (F(4)=0.1).

Alternative specifications of the model

APACS, using similar data, have found in previous models that the GfK measure of consumer confidence has significant explanatory power in explaining arrears of one or more months. As noted above, individuals may miss a payment due to forgetfulness, sickness or holiday. Short-term credit card arrears are therefore unlikely accurately to reflect financial pressure. Both MORI and GfK measures of consumer confidence and several of the sub-components of the GfK measure were considered in the model explaining arrears of three months as set out above. But none were significant.

On the basis of previous work (mainly on US data), we might have expected to find a role for the unemployment rate in the model. We tested several variants: the claimant count measure; the Labour Force Survey measure; and a measure based on employment. However none of these were statistically significant and they usually took the wrong sign. Charts A3.1 and A3.3 in Annex 3 suggest why this result occurs. The aggregate unemployment rate continued to rise through 1991 and 1992 when arrears had peaked and were beginning to decline. Since then unemployment has fallen more or less continuously whereas credit card arrears have increased steadily. But unemployment is negatively correlated with income with a lag, and income appears as part of income gearing. So some unemployment effects are already included in the model. In addition lenders do not typically provide credit cards to the unemployed or those without a regular source of income.

None of the wealth variables included in the model were significant, and again this is perhaps surprising given previous work on arrears. We also tested for liquidity effects. We expected a negative relationship between liquidity and credit card arrears. If households hold large amounts of liquid assets in relation to income they are perhaps less likely to default on credit card payments. However, when variables defined in terms of M4 deposits relative to income, or net financial assets relative to income were included they tended to have positive and insignificant coefficients.

We also considered whether it would be possible to test the proposition of Dunn and Kim (1999) that the proportion of the total credit line used might be a relevant factor. However, although there are data on the amount of unsecured loans and advances available to individuals and on the amount of these facilities drawn, there are several breaks in the series and data are not reliable back to 1990. Also, these data cover total unsecured credit rather than just credit card lending and could consequently not serve as a proxy for the variable we need.

Conclusion

The key influences on credit card arrears within the model presented here are income gearing and the number of credit cards in use. Surprisingly from a prior view, no measure of employment or unemployment was significant in explaining arrears. However inspection of the data shows no obvious positive relationship between arrears and unemployment.

3.3 Comparing the models

The single-equation estimates emphasise the importance of income gearing to the household sector's financial position. The unemployment rate is significant in the mortgage arrears model but not in the credit card arrears model.

Both equations estimated independently imply similar adjustment speeds to shocks away from equilibrium (two to three years), although the credit card arrears model adjusts slightly more rapidly. This may reflect the use of three-month arrears for credit cards and six months for mortgage arrears. It might also reflect the relative flexibility of the credit card market compared to the mortgage market and because credit card debt involves smaller amounts. It may be harder to reschedule payments in the mortgage market than in the credit card market. We also know from anecdotal evidence that individuals under financial pressure tend to default on unsecured debt before putting their home at risk by defaulting on mortgage repayments. However, although suggestive, these results cannot be used as a direct test of the speed of default on different types of debt: the definition of default differs in this empirical exercise. Credit card arrears are missed payments for three months whereas mortgage arrears are missed payments of six months or more.

The equations can also be estimated jointly, allowing the error terms to be correlated with each other, consistent with shocks being common to both types of arrears (using the method of seemingly unrelated regressions). For this purpose the equations are estimated over a common sample period using a simple dynamic framework. The availability of credit card arrears data limits the common period to 1990-2002 Q1. The credit card arrears equation is respecified in log-linear terms for this comparison, and shows little difference in parameters in this form when jointly estimated. However there are some differences in the estimated parameters for the mortgage arrears equation when estimated over this shorter time period. In particular the undrawn equity variable in the mortgage arrears equation loses statistical significance. Summary results are shown in Table B.

In order to assess whether the two types of arrears are caused by different influences we included variables originally excluded from the mortgage arrears equation but included in the credit card arrears equation to see if they improved the mortgage arrears equation. But these extra variables were not jointly significant. However this exercise suggests that total income gearing performs better than mortgage income gearing over this sample period (column 3). This conflicts with the results for the longer sample period reported above. The growth of secured debt since the mid-1990s might be a factor in explaining the increased importance of total income gearing.

Alternatively, when the variables originally excluded from the credit card arrears equation but included in the mortgage arrears equation were added to the credit card arrears equation there was a significant improvement in fit, primarily as a result of including the loan-to-value ratio (column 4 of Table B). This has a positive coefficient, possibly implying that a higher level of capital gearing on housing increases the probability of credit card arrears. That would suggest that differing mechanisms are at play. In the mortgage loan market a higher LTV reflects a judgment by lenders about the credit quality of borrowers. But for those borrowers with both credit card

and mortgage debt, a high loan-to-value ratio on mortgage debt suggests that they are more likely to default on the credit card borrowing when under financial pressure.

Finally we consider whether one type of arrears contains information for the other, by including lags of credit card arrears in the equation for mortgage arrears, and *vice versa*. The results suggest that credit card arrears contain some information for future mortgage arrears, but not the reverse. Although this corresponds with the prior that credit card arrears precede mortgage arrears, this finding may arise partly since credit card arrears are measured as arrears of three months whereas mortgage arrears are for a period of more than six months. So a common shock will be observed first in credit card arrears even if these arrears do not 'determine' mortgage arrears. Columns 5 and 6 report the preferred estimates from this joint testing. The mortgage arrears equation includes total income gearing and lagged credit card arrears as explanatory variables but the loan-to-value ratio is not statistically significant. In contrast the credit card arrears equation includes a significant (positive) coefficient on the loan-to-value ratio but no variable in lagged mortgage arrears. The restriction that the short and long-run responses of total income gearing are the same for both types of arrears is tested and not rejected (the equations in Table B only show the results from imposing the short-run restriction). Of course, in a full dynamic simulation of the responsiveness of the two equations together to an income gearing change, the final effect on mortgage arrears will depend both on the direct effects through the coefficient on income gearing, but also on the indirect effects operating from the credit card arrears equation. However the total effect from a change in income gearing calculated in this way is almost identical to the direct estimates obtained when the lagged credit card arrears variable is excluded from the mortgage arrears model. Overall, the results suggest that once allowance is made for interaction between the two types of arrears by including lagged credit card arrears in the equation for mortgage arrears, the speed of response to changes in the determining variables is not significantly different for the two types of arrears.

Table B: Joint estimates of arrears: sample period 1990 Q3-2001 Q4 using log-linear forms

	Mortgages (1)	Credit cards (2)	Mortgages (3)	Credit cards (4)	Mortgages (5)	Credit cards (6)
Constant	0.668 (1.0)	-5.730 (-6.0)	-1.561 (-2.5)	-15.82 (-3.4)	-0.4622 (-0.9)	-11.509 (-10.9)
Lagged arrears	-0.2436 (-3.2)	-0.2681 (-5.5)	-0.2035 (-2.5)	-0.2879 (-4.4)	-0.1881 (-2.7)	-0.2171 (-7.9)
Change in arrears (t-1)	0.2439 (2.2)		0.3153 (2.3)			
Unemployment (t-1)	0.3482 (2.9)		0.3375 (2.2)	0.1223 (1.2)	0.2984 (2.6)	
Undrawn equity (t-1)	-0.2891 (-1.0)		-0.1506 (-0.5)	0.9358 (1.4)	-0.6312 (-2.1)	
Mortgage income gearing	0.2180 (5.2)		-0.024 (-0.2)	-0.1997 (-1.0)		
Total income gearing		0.3497 (4.5)	0.3260 (2.2)	0.5817 (2.7)	0.3940* (-)	0.3940* (11.8)
LTV (FTBs)	-0.3846 (-2.1)		-0.064 (-0.4)	1.391 (4.0)	-0.2409 (-1.5)	0.9413 (6.0)
Active credit card balances (t-1)			0.0322 (0.3)	0.4944 (2.5)		0.3623 (12.3)
Lagged mortgage arrears (t-1)						
Lagged credit card arrears (t-1)					0.0616 (2.0)	
R-bar squared	0.897	0.763				
Standard error	0.0249	0.0492				
restrictions			F(6.33)=1.6	F(4,34) =8.0		

Note: Credit card arrears equation also includes seasonals and dummy for 1991 Q1.

* Coefficients imposed to be equal.

4 Conclusions and future work

We have shown in this paper how fairly simple time series models using mainly macroeconomic factors can capture the broad movements of mortgage and credit card arrears. The level of income gearing stands out as the major factor influencing both types of arrears. Although correlated with income, unemployment is found to have an additional direct influence on mortgage arrears. We

can find no such direct role on credit card arrears. That could reflect a lower takeup of credit cards by those liable to spells of unemployment. Another important difference in the explanation of the two different forms of arrears is the role of undrawn equity in mortgage arrears and increasing credit card penetration in credit card arrears. Having said that, the proxy variable used for increased penetration may not fully capture changes in behaviour by lenders.

Joint estimation suggests that the loan-to-value ratio on mortgage debt influences both types of arrears, but in different directions. However the response of mortgage arrears to the loan-to-value ratio is not robust over a shorter sample period. Joint tests show that total income gearing measures affect both types of arrears in much the same way across the two models, and that mortgage arrears are influenced by lagged values of arrears on credit cards. The reverse does not hold so that credit card arrears of three months appear to be a leading indicator of mortgage arrears of six months or more. Once allowance is made for this interaction between arrears the speed of adjustment in response to changes in the key explanatory variables is not statistically different for the two kinds of arrears modelled.

At the aggregate level, further work might seek to link household sector mortgage arrears to mortgage repossessions and credit card write-offs, and thereby analyse the implications of changes in arrears for the financial position of UK banks. More complete models of the stock-flow relationship of arrears at different durations might improve understanding of the dynamics between macroeconomic factors and household financial distress. At the disaggregated level, research might usefully consider survey and panel-based sources of data, such as the British Household Panel Survey, to identify those households with a higher risk of default and their characteristics. At the household level it is likely that changes in individual family financial circumstances (family formation, separation) may be at least as important as aggregate macroeconomic factors. One avenue for further work is to investigate in greater detail the micro-data, identifying whether there are particular groups of individuals that are more vulnerable to these shocks. This is particularly relevant to the Bank of England's work on financial stability.

We have used the number of credit cards as a proxy for the extension of credit card borrowing to less credit-worthy, and therefore riskier borrowers. Future work could use micro-data to conduct a similar study to that done by Black and Morgan (1998). This would allow us to test the hypothesis that credit has been extended to 'riskier' customers since 1995. It would also be interesting to look at spreads data, as Morgan and Toll (1997) did, to assess whether lenders are in fact taking account of this increased risk in their pricing policy.

Annex 1: Data sources

(a) Mortgage arrears model

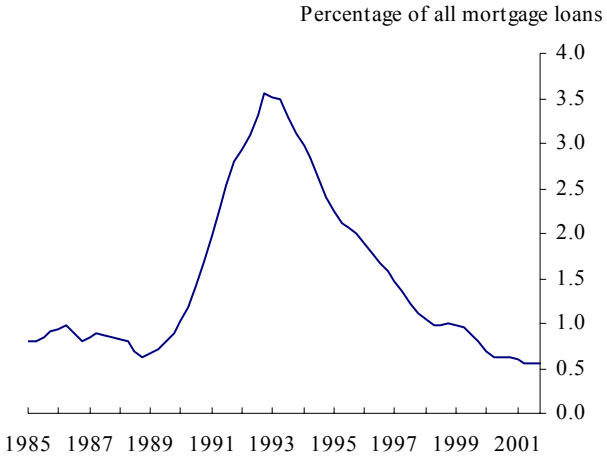
Variable	Source	Construction
Proportion of mortgage loans in arrears of six months or more (A6)	Council of Mortgage Lenders.	Taken from Table 25 of the CML *Housing Finance* publication, summing columns 9 and 11.
Mortgage income gearing (MIGM)	ONS.	Equal to the building societies' average weighted mortgage interest rate multiplied by household sector total secured debt and divided by total household disposable income. The mortgage interest rate is taken from Table 7.1J of ONS *Financial Statistics* and is the average weighted rate charged on all mortgages by building societies. Household sector total secured debt is total long-term loans secured on dwellings from Table 12.1N in *Financial Statistics* (code NNRP – AMWT used prior to 1987). Household sector disposable income is QWND from Table A40 of ONS United Kingdom *Economic Accounts*.
Unemployment rate (UR)	ONS.	Claimant count as a percentage of workforce jobs and claimant count. Code BCJE taken from Table 4.4 of *Economic Trends*.
Undrawn equity (UDEQUITY)	ONS.	Housing wealth minus mortgage debt as a percentage of housing wealth. Housing wealth is gross housing wealth, code CGRI from ONS. Mortgage debt is NNRQ+NNRR+NNRS from Table 12.1N of ONS *Financial Statistics*.
Loan-to-value ratio for first-time buyers (LTVFTB)	Council of Mortgage Lenders.	Taken from Table 17 of the CML *Housing Finance* publication (column 9)

(b) Credit card arrears model

Variable	Source	Construction
Credit card payment arrears of three months (A)	APACS.	Value of credit card payment arrears as a per cent of the total value of active credit card balances. Data provided directly by the Association for Payment Clearing Services (APACS), covering the majority of UK revolving credit card issuers.
Total income gearing (YG)	ONS.	Total household interest payments divided by household disposable income. Interest payments are code QWMG.Q from Table 14.8A from ONS *Financial Statistics*. Disposable income is RPHQ.Q from Table 14.8C from ONS *Financial Statistics*.
Unemployment rate (UR)	ONS.	Claimant count as a percentage of workforce jobs and claimant count. Code BCJE taken from Table 4.4 of *Economic Trends*.
Number of active credit card balances (B)	APACS.	Number of active credit card balances in the last month of each quarter from APACS data. Data provided directly by the Association for Payment Clearing Services (APACS).
Consumer confidence (CC)	MORI.	MORI aggregate measure of consumer confidence (percentage balances). Provided directly by MORI.

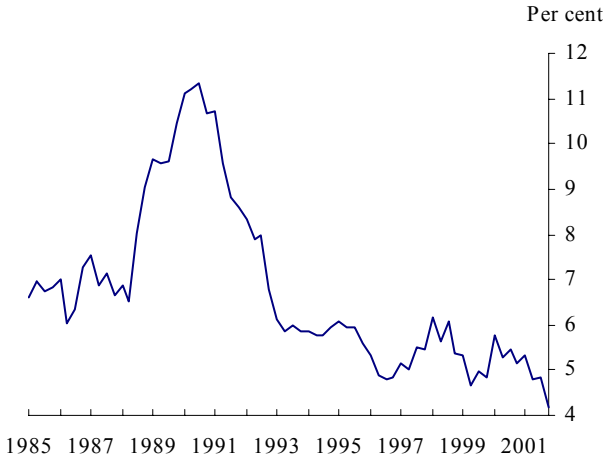
Annex 2: Charts of data for the mortgage arrears model

Chart A2.1
Mortgage arrears of six months or more



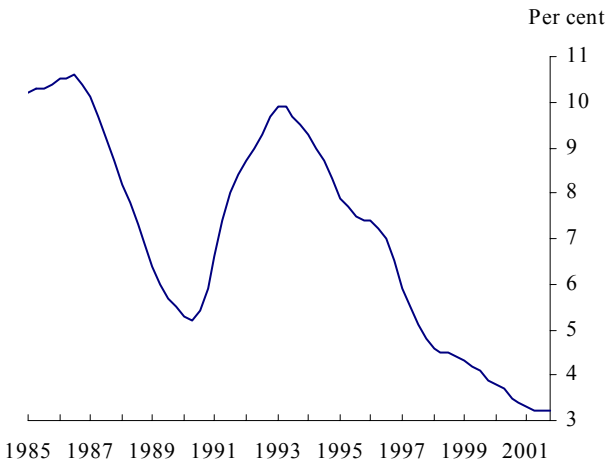
Source: Council of Mortgage Lenders.

Chart A2.2
Mortgage income gearing



Source: ONS.

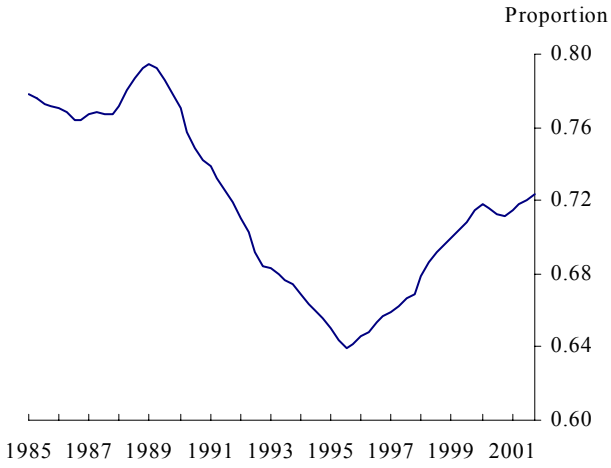
Chart A2.3
Unemployment rate [(a)]



Source: ONS.

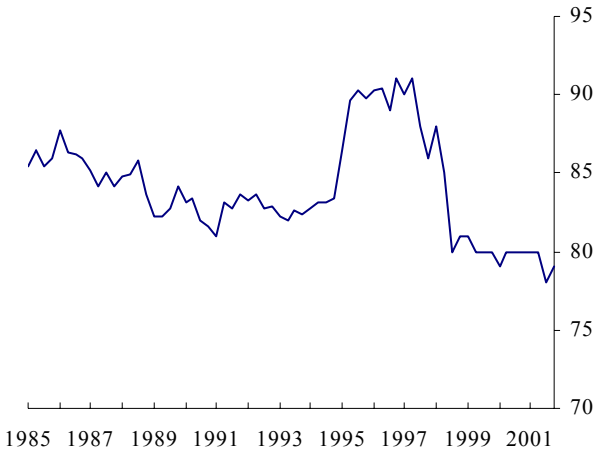
(a) Claimant count measure.

Chart A2.4
Undrawn equity



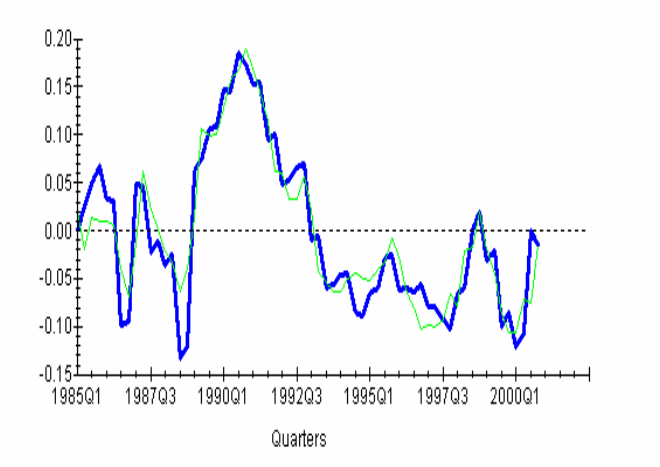
Source: Bank of England.

Chart A2.5
Loan-to-value ratio for first-time buyers



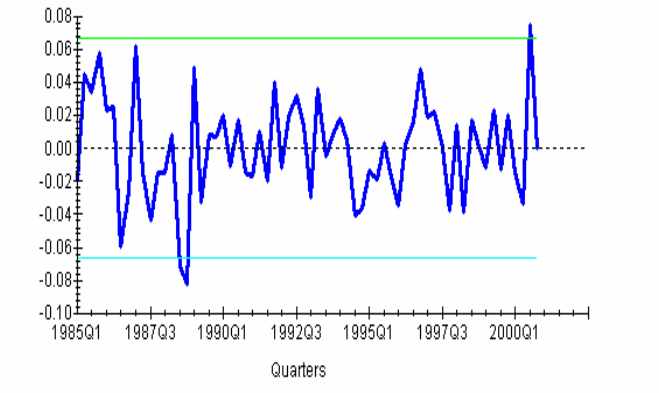
Source: Council of Mortgage Lenders.

Chart A2.6
Actual and fitted values of the model



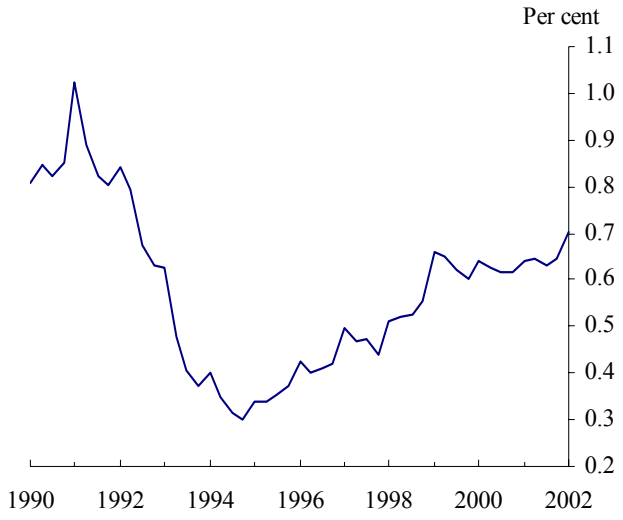
Sources: ONS, Council of Mortgage Lenders.

Chart A2.7
Residuals from the model and two standard error bands



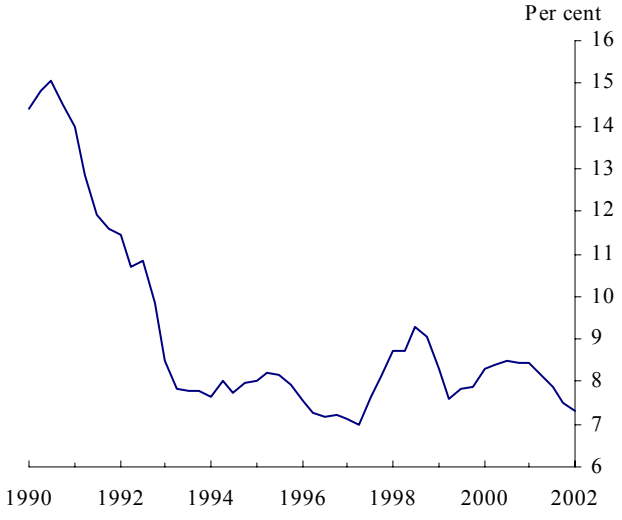
Annex 3: Charts of data for the credit card arrears model

Chart A3.1: Credit card payment arrears of three months[(a)]



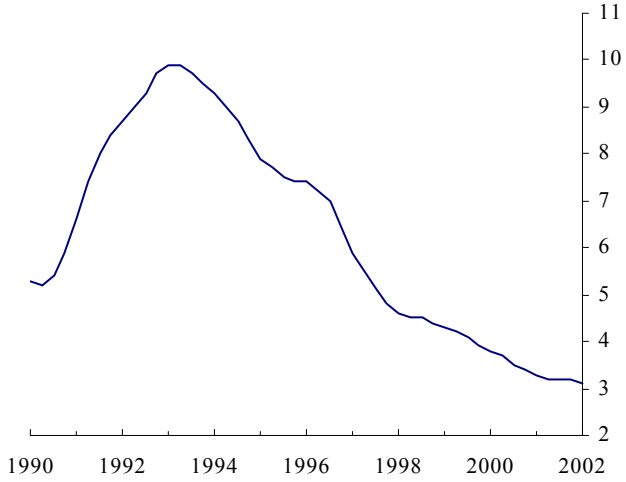
Source: APACS.
(a) Value of credit card payment arrears as a per cent of the total value of active credit card balances.

Chart A3.2: Total income gearing[(a)]



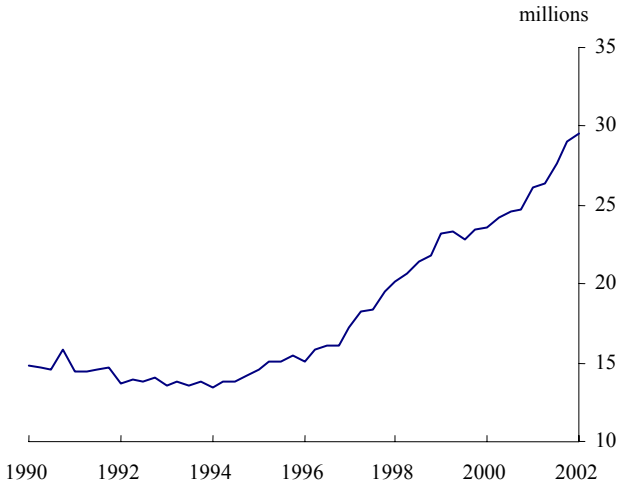
Source: ONS.
(a) Interest payments only.

Chart A3.3: Unemployment rate[(a)]



Source: ONS.
(a) Unemployment rate, claimant count measure.

Chart A3.4: Number of active credit card balances[(a)]



Source: APACS.
(a) Data provided by APACS cover the majority of UK revolving credit card issuers.

Chart A3.5: Actual and fitted values of the model

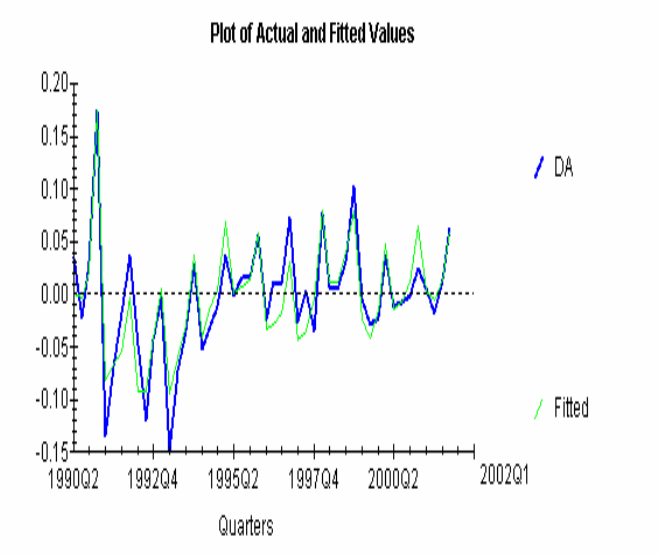
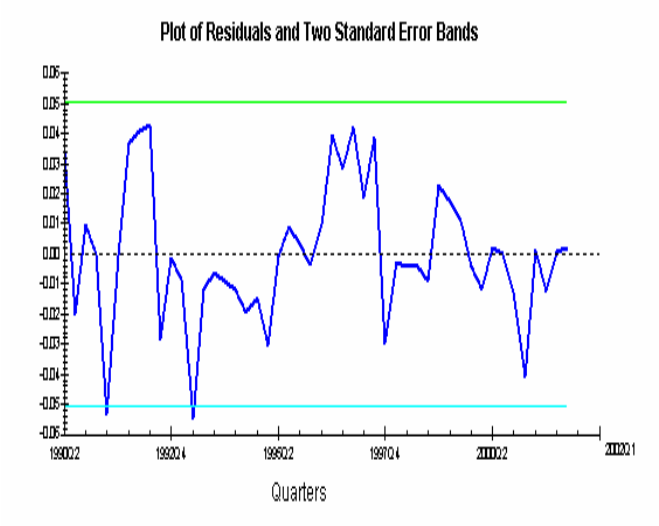


Chart A3.6: Residuals from the model and two standard error bands



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