Bank Credit Risk

by

E P Davis

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Contents

Abstract

The paper evaluates the contribution industrial-sector data on loan losses could make to diversifying and pricing bank risk.

It derives the mean, variance and cyclical sensitivity of sectoral provisions and writeoffs, then assesses implications for loan pricing; standards of capital adequacy; risk borne by sectorally-concentrated banks; and bank risk over time. Complementary econometric estimates for aggregate losses highlight the role of corporate gearing and rapid balance sheet growth.

It is suggested all banks should collect and employ sectoral loss data, and the analysis could be borne in mind for any future renegotiation of the Basle Accord.

Bank Credit Risk

1 Introduction

Loan losses are a normal aspect of banking business. The expectation that some borrowers will default lies behind a bank's pricing and diversification of risks, which are aimed to minimise the variability of distributable earnings over the cycle. Under normal circumstances, a diversified portfolio of loans with appropriate spreads(1) which reflect this expectation generates enough income to offset losses without call on own resources. To meet unanticipated losses, however, a bank may need to go beyond its profits and draw on its reserves or - ultimately - its shareholders' funds. Such capital, which is built up either from retentions or new equity issues, forms a buffer against insolvency during periods with temporarily high losses.

The Basle Accord on capital adequacy imposes minimum standards for internationally-active banks' capital adequacy (8% ratio of capital to risk weighted assets), based on a method of weighting assets according to their risk. Industrial and personal loans (except residential mortgages) attract 100% capital weighting, while mortgages are subject to only 50% weights. No explicit account is taken of covariances between risks, which could make contributions of sectoral loans to portfolio risk higher (if sectoral losses are highly correlated with the rest of the portfolio) or lower (if they are uncorrelated). However, countries are free to impose higher capital standards if they wish, and the minimum is supposed to be suitable for a fully diversified portfolio, with cyclically uncorrelated sectors offsetting highly correlated ones.

This paper uses data from a large UK bank on specific provisions and write-offs on UK domestic non-bank loans made via branches (which are around 50% of lending to customers) to evaluate standards for capital adequacy and bank regulation [this is the same dataset as is used by Rose (1991)]. Complementary data on spreads, on fees and on returns (net of losses)

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(1) That is, differentials of interest rates charged over the risk free rate.

unfortunately are not available. Assumptions about spreads and returns are needed to generate final conclusions about capital adequacy, although - as shown below - a great deal can be obtained from the data before this step is required. There is also no information regarding maturity of lending - and hence the flexibility of prices and quantities of credit.

The paper is structured as follows; in the second section, banks' behaviour in relation to losses is considered in more detail. The third section introduces the data, while the fourth shows its time-series properties. Analysis of the data commences in Section 5, which estimates the sensitivity of sectoral losses to the cycle. Section 6 assesses whether the current recession made much difference to the results of Sections 4 and 5. Sections 7-9 go on to assess the vulnerability of banks to insolvency, given Basle ratios. Section 7 carries out analyses using the full data set, to assess individual bank risk in relation to assumptions regarding spreads. Section 8 uses the data to construct measure of portfolio risk over time; while Section 9 constructs measures for less-diversified banks. Section 10 assesses stability of the covariances, while Sections 11-12 report econometric tests of the determinants of provisions and write-offs, which provide a framework for forecasting. A final section draws conclusions.

2 Banks' provisioning and writing-off practices

The behavioural response of banks to losses is crucial to the correct interpretation of the data. In general, they claim that they seek if at all possible to avoid showing an overall loss in their profit and loss account, which would imply a call on capital. Instead, they hope to offset any provisions (and eventual write-offs) against the stream of profits. In other words, capital is seen by the banks as a backup of last resort, rather than a form of buffer stock which is used regularly to absorb shocks to the balance sheet. This implies that banks set spreads on loans to cover all anticipated contingencies. However, this is contrary to the normal assumption of competitive pricing in efficient markets, which suggests that banks set spreads to cover mean losses over the cycle, plus a net return commensurate with their contribution to systematic (non diversifiable) risk. The banks' claims suggest that in some markets

competitive conditions allow spreads to be set higher than this, so as to cover losses from profits even in the depths of a recession. An offsetting factor is of course the effects of intense competition (often arising from new entry of banks to the markets), which puts downward pressure on spreads [Davis (1990, 1992)]. Various alternative assumptions regarding spreads are tested in Section 7, where it is also suggested why new entrants, lacking long term experience of credit risk, may easily underprice(2) . An additional buffer is provided by the return on equity, which at (say) 20% and with 4% equity/assets ratio (ie minimum tier 1 ratio against assets) adds 80 basis points to losses that can be incurred with showing an overall deficit; given dividend payments - and reinvestment of retentions - are discretionary, this can be devoted to loan losses when circumstances require.

Under current accounting conventions, there is an important distinction between provisions and write-offs in the urgency with which they are made. As the name suggests, provisions are made against the risk that loans will need to be written off, (as would be triggered by, for example, an interruption in interest payments). Sometimes the loan may perform after all, and thus the provision can be released. In general, accounting criteria for provisioning of non-performing loans are quite strict, and it is therefore difficult to delay (although they are not so strict that there cannot be some 'smoothing' at the margins). On the other hand, writing off, while it cannot be delayed indefinitely, is more discretionary. This could be justified, however, if there remains a positive probability the loan will be repaid (in which case the provision can be 'written back'). An economic factor underlying this difference is that in some cases writing off implies that the lender acknowledged the irrecoverability of the loan and so has a strong incentive/signalling effect, both on the borrower in question and others in

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(2) They will, of course, seek to avoid this by recruiting experienced bankers.

similar circumstances, that they need no longer strive to make payment.(3) In contrast, provisioning has no such negative signalling effect.(4)

The current approach could be criticised for its focus on 'book' as opposed to 'market' values of loans (ie not adjusting for impairment of value until loans are written off). However, if provisioning is accurate in reflecting loan impairment, then book values adjusted for provisions will approximate to market values. The assumption in this article is that provisioning *is* accurate in this sense - a separate case *could* be made to question this.

There are two types of provision, general (against the risk of loss on the whole loan book) and specific (against individual bad loans). The first is not tax deductible, whereas the second is. The data used in this exercise comprise only specific provisions, against domestic non-bank exposures, and hence are a subset (albeit a major one) of total provisions and write-offs made by this bank.

The discussion so far has concerned the banks. The regulators take a slightly different view, reflecting their sole concern with downside risk to banks (as well as their desire to not involve themselves in the detailed running of the banks). They accordingly focus on capital in their formal measurement system, and not the profit stream, since banks' capital is the ultimate protection against insolvency in the case that loan pricing is entirely incorrect and/or events occur that were not in any way predictable. (Provisioning practices themselves are also of relevance in this context, of course.)

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(3) This may, however, be greater in some cases (eg Latin American debt) than loans to the private sector, where the borrower need not know he has been "written off". Recoveries may in the latter case be a significant proportion of writeoffs.

(4) Indeed, in cases of large debts provisioning may have a positive signalling effect - it bolsters the bank's bargaining position, given the debtor knows that the bank is protected against the consequences of default.

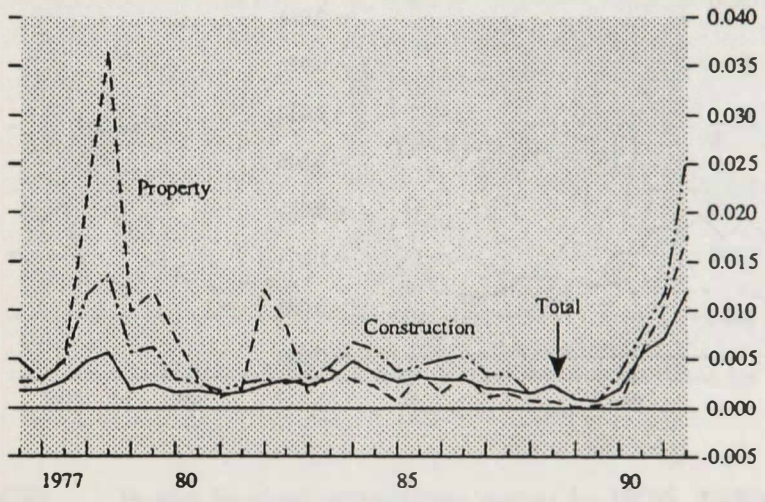
3 Data

The data are half yearly from 76H2-91H2, and are in 22 subsectors. (For a list of sectors, see Table 1.) To give an impression of the patterns involved, Charts 1-5 show net new and increased provisions and write-offs as a proportion of advances on the total domestic loan book, together with corresponding data for the construction and property sectors. Points to note include:

(i) Outturns for the property and construction sectors are more volatile than for the portfolio.

(ii) The level of write-offs lags the level of provisions[5] (unsurprisingly, given the act of provisioning is to allow for the *possibility* a loan will be written off). However, the lag appears to have shortened markedly in recent years.

Chart 1
Write-Offs - Total, Property, and Construction



(5) However, this cannot be proven for individual loans since the data only show aggregate patterns.

Chart 2
Provisions - Total, Property, and Construction

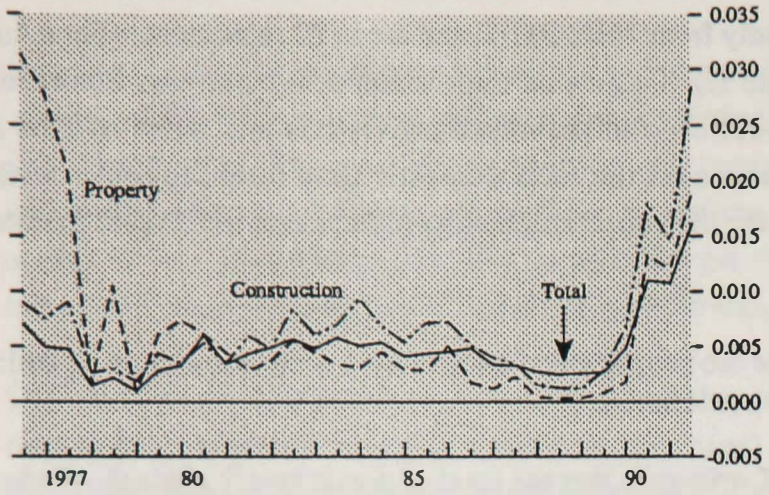


Chart 3
Provisions and Write-Offs - Total

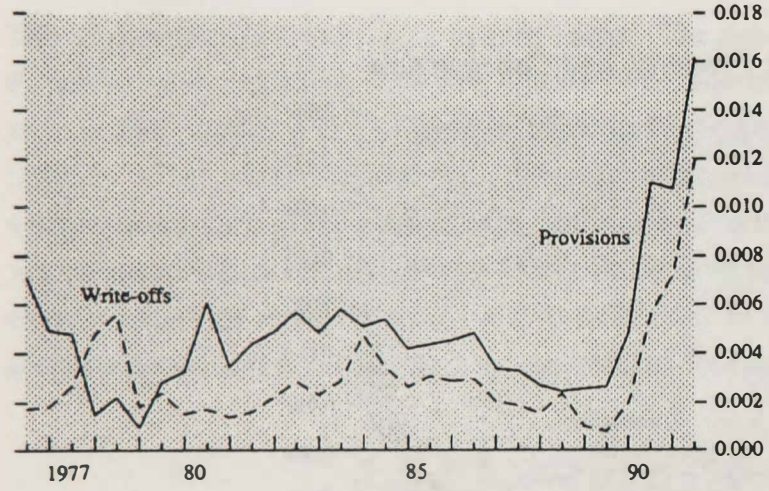


Chart 4
Provisions and Write-Offs - Property

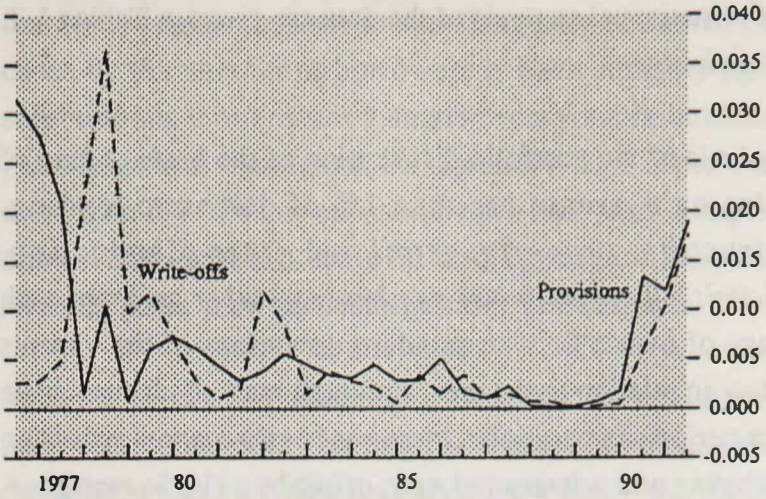
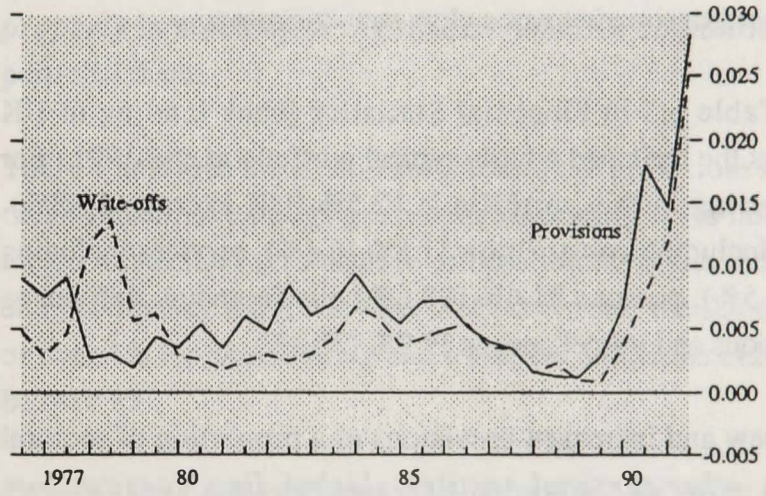


Chart 5
Provisions and Write-Offs - Construction



(iii) Peaks in total provisions occur in 1976, 1980 and 1991, peaks in write-offs in 1978, 1984 and 1991.

(iv) The current recession shows overall loan losses far in excess of experience at any time since 1976. Property, in contrast, underwent similar losses in the late 1970s.

4 Statistical analysis

The results of the initial statistical analysis of the data are given in Tables 1-7. Comments on the tables follow.

Table 1 shows an analysis of the portfolio distribution of the bank. Many of the sectors comprise on average less than 1% of domestic lending. *Agriculture*, *construction*, *property*, *retail* and *other distribution*, *professional/scientific/miscellaneous*, *house purchase* and *other personal* each account for an average of over 5%. The standard deviations of the various shares are generally low in relation to the means, though marked changes have occurred over the data period. In particular, there has been a marked reduction in lending to manufacturing and primary industry, offset by a rise in *mortgage*, *miscellaneous* and *property* lending, while services have remained flat. The economic data suggest these largely reflect trends in the economy (ie because these sectors have changed in size or increased their borrowing) although banks' entry to the *mortgage* market was a clear strategic move.

Comparison with Table 6.7 in Financial Statistics (bank lending to UK residents) reveals that the bank had a fairly typical portfolio at end-1991. For example, manufacturing in this portfolio is 12.5% (UK average 10.8%), primary production including construction 11.8% (6.4%), services including property 24.3% (27.5%), persons 31.6% (28.0%) and financial, defined as including the professions and miscellaneous 19.9% (27.3%).

Table 2 shows net new and increased provisions as a proportion of sectoral lending. *Transport*, *other personal*, *textiles*, *shipbuilding*, *construction*, *property* and *miscellaneous* show particularly high mean levels; *house purchase* and (naturally) the *public sector* much lower. A number of the vulnerable sectors are characterised by high proportions of small firms; others, such as *textiles* and *shipbuilding* are declining industries and/or cyclically volatile.

Of course, mean losses should be distinguished from their variability (indicating total risk) and their contribution to portfolio volatility (non-

diversified[6] risk - see Section 5). The standard deviation of provisions to *shipbuilding, property and transport* are both large in absolute terms and markedly higher than the mean. This may of course be influenced in some cases by the number of borrowers in each category eg if there are only two shipbuilders, it only takes a single event (one failure) to produce a very high percentage loss. As regards the maximum level experienced, this is sometimes more than 5% of loans outstanding per half year. Simple correlations are also shown between the sectoral and aggregate losses; *construction* and *miscellaneous* show particularly strong correlations.

Table 3 shows corresponding descriptive statistics for write-offs as a proportion of sectoral lending (as noted, historically write-offs have lagged provisions, although they are becoming closer). As for provisions, half yearly mean write-offs vary considerably between sectors, from less than 0.05% for *mortgages* to 0.59% for *property companies* and 0.68% for *shipbuilding*. The patterns are broadly similar to provisions. As shown in Table 1, the result for *property* is much more significant than for *shipbuilding*, given its high portfolio share.

Table 4 analyses the first differences of the provisions and write-offs; how much faster have things got worse historically? As might be expected, the means are around zero and are of little interest. But the standard deviations and maxima are more relevant. For provisions, the standard deviations are at or over 1% for *shipbuilding* and *transport*, while the maximum increases can be over 3%.

Table 5 shows tests for normality of the data. As might be expected, the data are log-normal rather than normal, since losses cannot be negative, and most obervations are clustered around zero. For this reason, we focus largely on logs rather than levels in the econometric analysis below.

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(6) Unless the additional assumption is made that this bank is totally diversified, we cannot necessarily assume the risk is not diversifiable.

Tables 6 and 7 tests for stationarity in the series ie whether the sample is trended. Clearly this cannot be true in the long run but may be a feature of this subsample. A small number of the series are neither levels stationary [I(0)] nor difference stationary [I(1)], notably construction. These results may relate to the patterns shown in the charts, with a sharp increase in losses at the end of the sample.

5 Cyclical sensitivity of losses

This section focuses on the beta coefficients given in Tables 8 and 9, obtained by regressing the log of the grand total of losses as a proportion of advances plus a constant on the log of proportionate provisions and write-offs by sector, where the beta coefficient (on the grand total) indicates the degree to which sectoral losses covary with losses on the portfolio (if total provisions rise x per cent, sectoral provisions rise βx per cent). It hence indicates the degree to which risk in loans to individual sectors is not diversifiable and should be charged for in spreads and allowed for by capital adequacy requirements. (It shows which industries offer the greatest proportionate drop in return when returns on the loan book as a whole fall.) Mathematically, the contribution to portfolio variance is given by the weighted covariance, the proportionate contribution to portfolio risk is this divided by the portfolio variance and beta is this without the weight. Note that this is distinct, albeit related, to the use of beta in the Capital Asset Pricing Model. The betas can in principle be used to estimate directly the appropriate pricing of loans.

The stationarity results cast light on these data as, in effect, the validity of the estimates is dependent on the stationarity of the series, and this indicates that in many cases the difference is the more appropriate equation to focus on. In any case, the results are reasonably consistent with each other, as well as with the earlier work by Rose (1991). In levels, *construction*, and *property* are shown to be particularly sensitive to the general pattern of losses ($\beta > 1.0$) both for provisions and write-offs. (Although the results for stationarity offer grounds for caution in interpreting the results for construction.) Provisions are arguably more important to the stability of the bank (in contrast, write-offs have very little significance.) In addition to those noted above, the cyclical sensitivity of

provisions to *transport and communications food drink and tobacco* comes through strongly. In differences, provisions for *metal manufacture*, other *engineering* and *'other financial'* also have betas of over one. In contrast, sectors such as *house purchase* and *other personal* lending have low correlations with total provisions, as do much of the manufacturing and financial sectors.

Subject to their statistical validity, the results of Sections 4 and 5 indicate sectors where there are high *mean* losses, a high *variance* of losses and high *covariances* as well as a high *portfolio share* (see Table 10). The sectors emerging on all the criteria are *construction and property*. *Professional, scientific* and *miscellaneous* and *other manufacturing* are again above average in most cases. The implication of the covariance results, assuming the covariance are stable (Section 10), is that except in the most diversified of portfolios, Basle norms of 100% weights for all loans with no account for covariances appear oversimplified. Ideally loans to the *property* sector and, more tentatively, to the *construction* sectors, should have higher margins than their mean losses would imply, could carry higher risk weights and could be considered for explicit supervisory limits via extensions of controls on concentration of risk to a sectoral level. Equally, sectors which are uncorrelated with the portfolio should have *lower* risk weights(7) (ie all loans should be graded by risk and not merely those with a highly uncertain return). A fully diversified portfolio might then have an *overall* ratio of 8%, composed of different weights on different types of loan.

Of course, it should be remembered that loans to sectors are not homogeneous. Indeed, from the behaviour of banks it would appear that it is often variances *within* sectors that are more important. In addition, large exposures policy (to individual firms) may capture some of the heightened risk. Third, there may be international differences in sectoral vulnerability (where Basle was aimed to approximate the appropriate level for a variety of countries).

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(7) This is, however, not permitted under the Basle Agreement (ie national authorities may not set risk weights below the common level, although they may set them above it).

The results are broadly similar when the exercise is repeated with the variables defined linearly. However, given results for normality (Table 5), this is less relevant and is not reported here.

6 Excluding the current recession from the dataset

The data set, as shown in the charts, is strongly influenced by the current recession. This prompts the question of whether the results are unduly influenced by the recession, and whether the observed patterns were present in the data prior to the recession. Answering these questions also casts light on further issues, particularly the stability of the covariances (see also Section 9). In order to address these questions without repeating the whole exercise, we ran the tests for 1976-89 and focussed on five sub-sectors, namely *construction*, *property*, *professional*, *subtotal* (manufacturing and services), and the *grand total*.

Results are as shown in Table 11; they bear out and partially reinforce the main analysis. The means and standard deviations for these sectors remain above average. The beta coefficients are comparable for *property*, *construction* and the *manufacturing/services* aggregate. Those for *professional services* are lower. It is notable that property could, from these data, have been seen to have a highly uncertain return, even before the current recession. Historical UK experience and much international experience would have bolstered this conclusion [Davis (1992)].

7 Losses and capital adequacy

Tables 12 and 13 use the full data set in a slightly different way, to assess sectoral losses as a proportion of the balance-sheet total (instead of the losses as a proportion of loans to each sector). This enables one to evaluate capital adequacy in a rough and ready way, by seeing how bad actual loss experience has been, given actual lending decisions, and how bad it could have been in the worst possible case. The results for provisions show that the worst loss which occurred at any time in a half year was an annualised 3.23% of advances. Note that if expected losses were calculated using a normal distribution the highest

point on a 95% confidence band, ie the mean plus two standard deviations, would give only 2.19% on the portfolio. There are two reasons why this rule-of-thumb (that banks might nonetheless apply) is incorrect. First, as shown above, tests suggest that the distributions are lognormal rather than normal. Second, there remains some evidence of excess skewness (ie more observations in the upper tail than would normally be expected).

As an alternative, adding the maxima for each sector (ie everything going bad at once) gives an annualised total for each sector of 4.1% (compared with 2.8% adding the 95% confidence level for individual sectors). The results for write-offs, which show a maximum of 2.8%, follow similar patterns. This, of course, takes the extreme assumption of perfect positive correlation between returns. The portfolio analysis above takes better account of diversification, although the current calculation also offers useful information on the upper tail of the distribution.

As noted at the outset, banks seek to cover most losses by use of the profit stream rather than capital. Suppose, however, that regulatory capital were brought into play (in practice, this has not occurred for major UK banks) due to extreme or unanticipated events, or ex ante underpricing of risk. How well does regulatory capital measure up? On the face of it, the numbers compare favourably with the Basle ratio of 8% (assuming Tier 2 capital performs effectively). But capital should be sufficient to absorb all future losses on the existing portfolio, not just one year's loss (imagine a liquidator running the bank down and using up capital as the book matures). In this context, one relevant fact, as shown in Table 14, is that losses are strongly autocorrelated, with a rise in provisions in one half year often followed by another next year.

In the light of this observation, a further exercise was performed to test for the importance of this effect, namely to cumulate losses across time while assuming different risk spreads charged by banks. A possible assumption is that spreads will be sufficient to cover mean losses on a given asset category over the cycle (ie we assume that pre-bad debt margins equal mean historic provisions). As noted, in practice spreads may exceed this level. We suggest that although write-offs are more conclusive in an accounting sense, the fact

that provisions must be written against regulatory capital and are rarely released until much later makes it legitimate to focus on provisions. *It is important to note that the assumptions are totally artificial and entirely unrelated to the behaviour of the bank supplying the data, information on whose pricing behaviour is not available.*

The mean annual level of provisions on the portfolio is 0.98% over the whole sample, or 0.49% half yearly. We accordingly subtracted this from provisions each period and accumulated to show whether capital would be called upon at any time (ie if the series becomes positive).(8) The result is that although there are periods, notably in 1990-1 when provisions rise sharply in successive periods, income is always sufficient to prevent any call on capital (and obviously, at the end of the period, there is break-even). However, when the average provisioning is measured up to end-1989, the implied risk premium is only 40 basis points. In this case, as shown in Chart 6, losses over 1990-1 amount to nearly 3%. The picture is even worse at a spread of only 30 basis points which, if not adjusted, implies losses of 6%. Of course, in practice a bank would adjust spreads where possible,(9) and seek to issue new capital. We note the benefit of having consistent data showing losses in the late-70s, which would temper views of risk. A bank without such systems, or a new entrant, would only have more recent experience to go on, and given the low level of losses in the mid to late-80s, as shown in Charts 1-5, might underprice severely. The implication is that publication of the industrial incidence of losses for banks collectively might be a useful service.

As noted, write-offs are the conclusion of the default process, when losses are judged as irrecoverable. Given that some provisions are eventually written back, in the long term it could be argued write-offs are more relevant than provisions. However, the writing back may be a protracted process.

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(8) Note there is an implicit - and possibly incorrect - assumption, that the level of provisions at the beginning of the period was zero. Also general provisions are ignored.

(9) We note that quite apart from market pressures on spreads, the adjustment to changes in risk takes time because of long maturities over which term facilities are provided.

Moreover, although provisions are often reduced by writebacks of past loans, given lags, there are dangers in basing a risk premium on write-offs. Chart 7 shows that write-offs can in principle be covered at lower spreads of 30 basis points.

Chart 6
Accumulated Provisions at Different Risk Premia

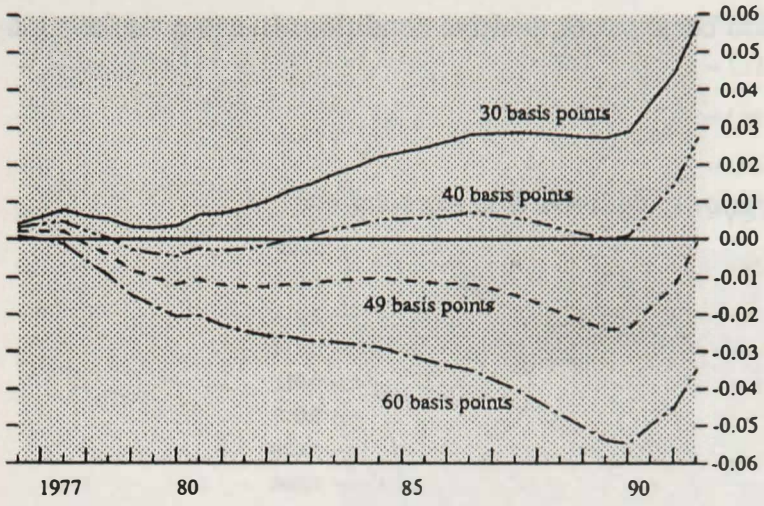
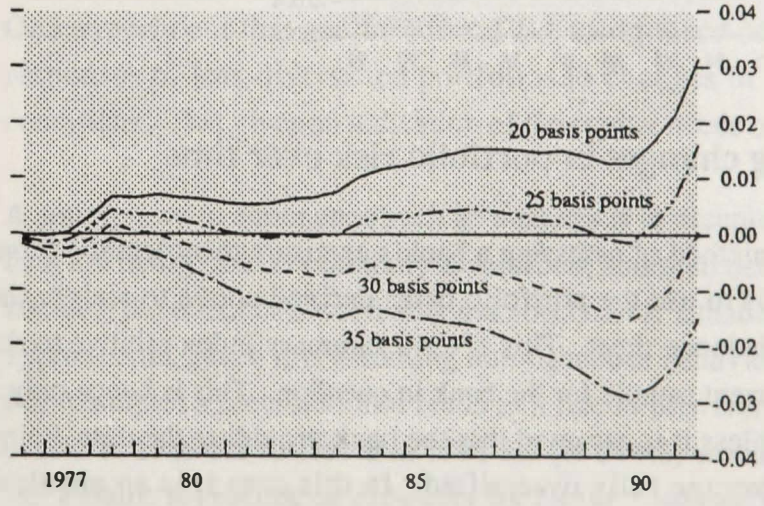


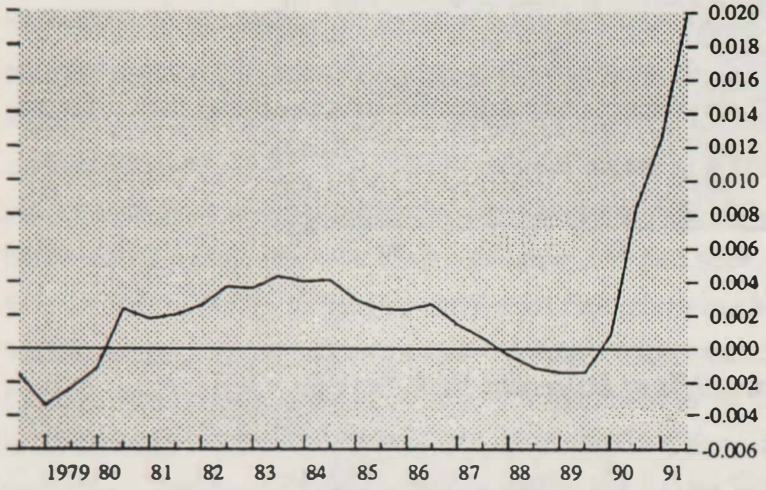
Chart 7
Accumulated Write-Offs at Different Risk Premia



A further exercise was to assume a process (adaptive expectations) whereby a bank sets spreads according to a weighted moving sum of the last four half

years' provisions (Chart 8). This could be seen as a form of 'disaster myopia' whereby a period of calm leads a bank to underprice risk [Guttentag and Herring (1984), Davis (1992)]. In this case, the result has a similar profile to the 40 basis point spread in Chart 6, with again mounting losses over 1990-1. One offset is, as noted, that dividends can be passed in order to bolster provisions. But on the other hand, it may be difficult to change spreads continuously on the whole book in this manner, both due to long term (eg syndicated) loans, and because competitive conditions in some markets may prevent it.

Chart 8
Accumulated provisions: adaptive loss expectations

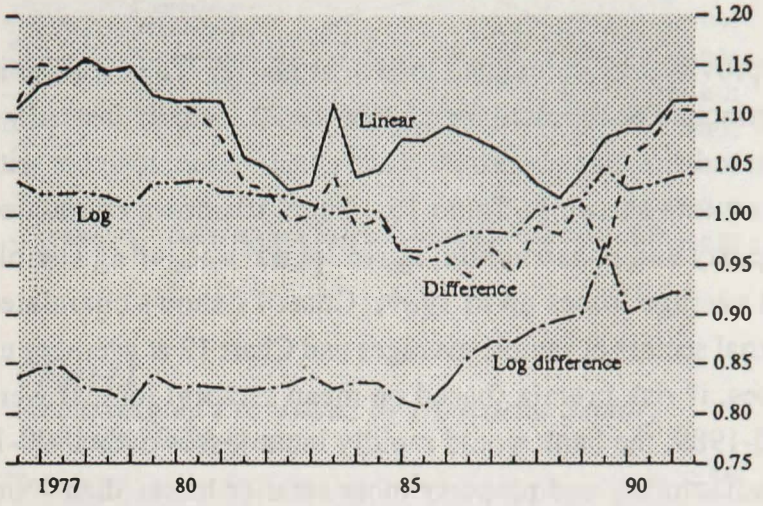


8 Assessing changes in portfolio risk over time

A rough and ready method of assessing a bank's exposure to systematic (non-diversifiable) risk is to use the portfolio betas derived above to weight the components of the balance sheet. This gives a summary index relative to the average over the current sample for the bank in question. This is hence only a relative measure, unless it is assumed that the bank providing the data, being large, is also on average fully diversified. In this case it is an absolute measure. The measure is shown in Chart 9 for all four of the beta measures (level and difference, linear and log). They are broadly consistent in showing a rapid increase in exposure in the late 1980s (before the current recession) and

in three of four cases also high exposure in the late 1970s, in the aftermath of the mid-1970s property crisis. Cross reference to Table 1 suggests that this is related to heightened exposure to property companies.

Chart 9
Indicators of Balance Sheet Risk (Means of Calculating Betas)



9 Less diversified portfolios

One experiment that can be carried out using these data is to simulate the responses of less-diversified portfolios to changes in aggregate economic conditions. This gives an indication of the capital needs of small banks.

A simple way to commence such an analysis is to assume that the bank whose data are being used is optimally diversified, and then use the sectoral betas to simulate the effect of a worsening macroeconomic situation. (This will only be approximate, given it is assuming homogeneous behaviour of sectoral loans.) For example, a recession that leads to a rise in provisions by this bank from 0.25% in 1989 H1 to 1.61% in 1991 H2 (ie 644%) would increase provisions for a bank investing in *property* by (Beta * increase) ie 9 times. So if provisions on property began at their mean of 0.67% then provisions would rise to a half yearly 6%.

A more sophisticated approach is to compute descriptive statistics for subsectors of the economy, namely the *primary* production, *manufacturing*, *services*, *personal* and *financial* sectors. These data are given in Table 15. *Primary* production (which is defined to include construction) and *services* (which include property) are indicated to be most volatile, but all the sectors considered alone - apart from loans for persons - are riskier than the aggregate portfolio in terms of mean and variance of provisions.

A third estimate is provided by cumulated losses, as above. The exercise in Section 7 could in principle be repeated for each of the 22 sectors; instead we focussed on the most volatile, namely *property* and *construction*, together with the five industrial sectors shown in Table 15. Chart 10 shows cumulated provisions for *property* and *construction*, at risk premia covering sample average losses and average losses up to 1989; Chart 11 shows cumulated losses for the industrial sectors at sample averages and Chart 12 at averages up to 1989. In all cases, if risk premia (based on mean sectoral losses) were estimated up to end-1989, the bank would rapidly incur losses over 1990-1. Note that both manufacturing and property incur smaller losses than some other sectors, given the adverse experience in earlier years. Owing to diversification, the portfolio risk for a fully diversified banks, as shown in Chart 6 (40 bp line), is much less than for several of the industrial sectors.

Chart 10
Accumulated Provisions, Property and Construction

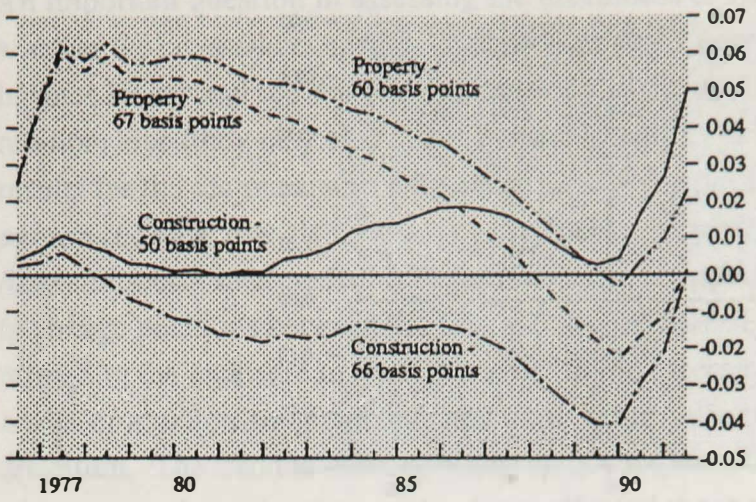


Chart 11
Accumulated Provisions by Industrial Sector, Spreads 79-91 mean

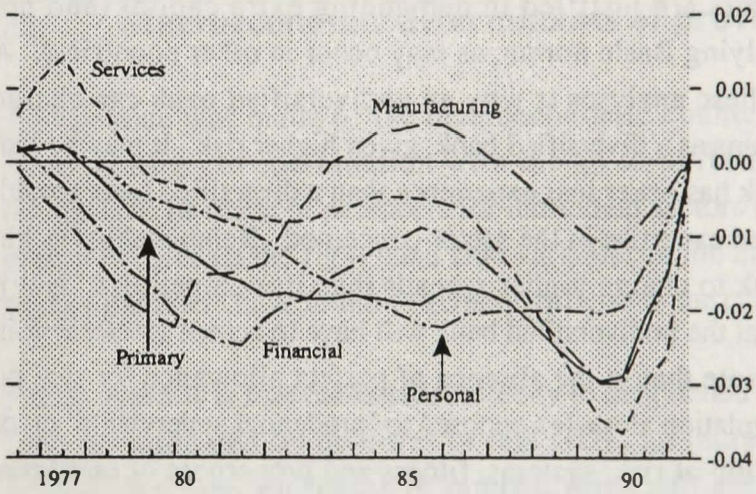
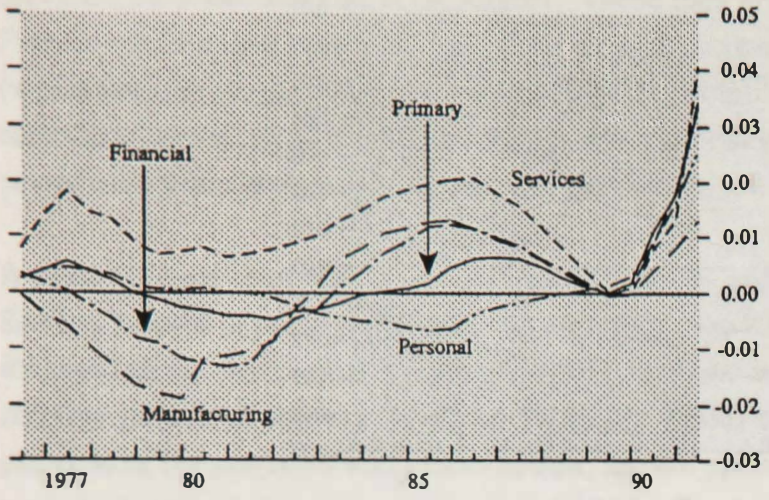


Chart 12
Accumulated Provisions by Industrial Sector, Spreads 76-89 mean



These results imply that undiversified banks are riskier than diversified (which in turn might be correlated with size), even taking account of credit risk alone, and hence supervisors are justified in demanding extra capital (and not mechanistically applying Basle norms, as may occur in other countries). A question posed by these analyses is why an undiversified bank can charge similar spreads on loans as a diversified bank, given higher risk. It may be that the undiversified bank has better loss experience than a diversified bank would, because of specialised expertise in the sector concerned. Relationships might even enable the bank to charge higher spreads than its competitors. But it seems more likely that the undiversified bank will have to accept greater risk in order to compete. Note that in the absence of perfect allowance for risk on each loan, capital regulation alone (as opposed to 'prudential supervision' eg of liquidity, concentration of risk, systems, fitness and properness of managers etc) does not in itself prevent risk taking - indeed it may stimulate it as banks are encouraged to hold high-risk assets within each risk category. Rather, it protects from the consequences of it.

10 How stable are the covariances?

An important question in assessing the usefulness of the sectoral analysis is whether the covariances can be relied on over time. Clearly, major changes in balance sheets and the sectoral vulnerability of the economy may change the relationships (they may also differ transnationally). Table 16 shows that the results for the sectors are broadly consistent when split into subsamples, with *personal* being low risk, *services* (including *property*) high risk and the *financial* sector intermediate. The *primary* and *manufacturing* sectors appear to change positions between the first and second half of the sample, probably reflecting the exposure of *manufacturing* to the recession of the early 1980s, while *construction* (primary) has been more vulnerable in the current downturn. The trend towards splitting up of conglomerates (raising volatility of borrowers' earnings) may also have affected these patterns, although its greatest effect might have been expected in *manufacturing*, which is not borne out here.

11 Macroeconomic determinants of provisions

An estimate was made of the macroeconomic counterparts to heightened provisioning. In combination with the sectoral results this would allow forecasts to be made of prospects for individual sectors (subject, of course, to ability to forecast the right hand side variables in the macro equation, which many forecasters have found extremely difficult in the current recession).

The hypothesis is that banks react directly to heightened risk that loans will go sour, as indicated by declines in real GDP, an increase in the corporate bankruptcy rate, increases in interest rates and high corporate gearing (measured as gross debt/capital stock). Bankruptcy and GDP, though related, are not identical since bankruptcies tend to lag the cycle, and have become more common over time. Note the interpretation of bankruptcy is as an indicator - loans to firms which are liquidated would (generally) already be provisioned against and written off. There is a risk of multicollinearity between liquidations and provisions.

Results are as shown in Table 17. In the long term the rate of provisioning is positively related to the real interest rate, the corporate bankruptcy rate and the corporate capital gearing ratio (bank borrowing as a proportion of the capital stock), while it is negatively related to the growth rate of GDP. A sustained one percent fall in the GDP growth rate raises the long-run rate of provisioning by 14%; a 1% rise in the level of the bankruptcy rate rises provisioning by 1.7%; a 1% rise in capital gearing raises provisioning by 0.73% and a one percentage point rise in real rates from an initial level of 4% raises provisioning by 8%.

The dynamic equation shows similar responses to the main variables, though it also exhibits autoregressive properties, with a significant negative lagged dependent variable. The forecasting performance of the equation estimated up to 1989 H2 over the 1990-1 recession is good, with the increase in provisions comparable with actual experience, despite the absence of commercial property prices from the equation. We suggest that the key variable is corporate capital gearing, which captures the major difference between this recession and the last.

Using this specification as a base, we tested certain extra independent variables:

- the *growth rate of the balance sheet* lagged a year has a sizeable and significant positive effect on the rate of provisioning in the dynamic equation (coefficient 0.97, t value 2.5). It improves the fit of the equation as a whole, and its forecasting ability (Chow (4) = 0.9) at the cost of inducing some autocorrelation (LM(2) = 6.8). This supports the view, confirmed by evidence for the whole UK banking sector and transnational experience [see Davis (1992)] that attempts to grow balance sheets rapidly often leads to a disportionate share of bad loans, given likely increases in adverse selection and moral hazard.

- variables that were not significant, either in the cointegrating vector or dynamic equation, included *commercial property prices, nominal interest rates*, and *share prices*.

The results reported in this section suggest that spreads should be determined by gearing as well as standard macroeconomic variables.

12 The relationship between provisions and writeoffs

A bank provides against loans in advance of writing them off, hence provisions alone should be usable to explain write-offs, and anecdotal evidence suggests that the lag between provisioning and writing off has declined quite substantially in recent years. Reasons for this may include the expansion of small companies, where given little collateral, banks cut their losses by writing off the loans relatively rapidly. In an attempt to explore this relationship, a simple difference equation was estimated relating the two variables with a lagged ratio term to illustrate a tendency for banks to increase the level of provisions when the write-off/provision ratio increases. Estimated up to 1989 H2 this gave the equation shown in Column 1 of Table 18, with quite long lags. In contrast, the lags are much shorter for the full sample (Column 2), and also the coefficient on the error correction term is larger. The change in behaviour is observable in the marked underprediction of write-offs by the equation estimated up to 1989 H2.

Conclusions

The key results are as follows:

- There are significant differences between industrial sectors in the mean and variance of losses.
- The losses vary sharply in the degree to which they covary and hence contribute to non-diversifiable risk.
- The most volatile sectors often have a high portfolio share.
- If it had been possible to forecast the depth, length and incidence of the current recession, the data could have helped predict the pattern of losses.

- The 'worst case' in an individual period was an annualised 3.2% level of provisions in relation to advances. This is well beyond two standard deviations above the mean, the conventional measure of significance.

- Since losses are correlated over time, cumulation may be more relevant than looking at one period in isolation. Artificial calculations based on assumed spreads show that slight underpricing of risk in this context, which might appear justified by a backward-looking perspective, can lead to calls on capital, or the need for sharp increases in spreads. Of course overpricing may be equally undesirable, given it may lead to misallocation of resources and/or disintermediation.

- The covariances can be used to assess exposures of a (large, diversified) bank to systematic risk, which again shows an increase in the 1980s.

- The data can also help to evaluate less-diversified banks' portfolios responses to changes in economic conditions and vulnerability to underpricing. The general results support higher capital ratios for such institutions.

- The sectoral covariances are reasonably stable over time, although shifts in response to economic conditions cannot be ruled out. In other words, the analysis cannot be used mechanistically without a view of structural developments in the economy.

- Aggregate provisioning is related to GDP, interest rates, bankruptcies and corporate gearing. The importance of gearing offers an explanation for the failure of simpler approaches to capture the increase in risk at the end of the 1980s.

- The lag between provisions and write-offs - for this bank - has become significantly shorter over time.

The degree to which the results generalise depend on the view taken of how 'typical' this bank is, and how diversified across the entire economy. In our view it fulfils these criteria adequately (cf Section 4).

These results imply that collection of sectoral data on loans, provisions and write-offs is helpful to banks' pricing decisions. Data on spreads and returns as well as losses would help an assessment of the accuracy of risk pricing. The analysis also casts light on the limitations of the current Basle capital adequacy agreement.

Further research in the light of the analysis could include an examination of the effect of firm size on credit risk, and whether it dominates the sectoral effect; investigation of patterns in other countries, particularly those with 'relationship' as opposed to 'transactions' - based banking systems, also an investigation of risk at the level of the banking sector as a whole; and application of the methodology to other types of risk such as market risk to which banks are exposed.

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TABLE 1: ANALYSIS OF PORTFOLIO DISTRIBUTION

	Mean %	Standard Dev %	Min %	Max %	1976H2	1991H2
Agriculture	7.3	2.2	3.2	10.4	6.7	4.3
Mining & quarrying	0.5	0.2	0.2	0.9	0.8	0.3
Construction	6.8	1.8	4.4	10.5	10.3	7.2
Food, drink & tobacco	2.2	0.8	1.1	4.5	4.5	1.6
Chemical & allied	1.3	0.8	0.5	3.1	2.4	1.0
Metal manufacture	0.7	0.3	0.2	1.6	1.6	0.3
Electrical engineering	2.0	0.3	1.5	2.7	2.2	1.7
Other engineering	4.4	2.0	2.0	7.7	6.5	2.8
Shipbuilding	0.3	0.1	0.1	0.7	0.4	0.2
Motor vehicles	0.9	0.6	0.2	2.0	2.0	0.2
Textiles, leather, clothing	2.1	1.2	0.8	4.7	4.4	1.1
Other manufacturing	4.1	0.8	2.7	5.6	4.5	3.6
Property companies	7.1	2.3	4.9	12.3	8.5	12.2
Transport & communication	1.9	0.4	1.4	2.7	1.8	1.7
Central/local government	0.3	0.2	0.2	0.8	0.8	0.3
Retail distribution	6.5	1.2	3.9	8.2	6.8	5.1
Other distribution	5.0	0.6	3.8	6.3	5.3	5.0
Insurance & pensions	0.4	0.2	0.05	0.9	0.2	0.5
Other financial	1.7	1.4	0.7	8.5	1.6	1.0
Professional/ scientific/ miscellaneous	13.7	2.1	10.4	18.4	10.4	18.4
House purchase	15.1	7.3	4.7	25.7	6.0	18.8
Other personal	15.6	3.7	12.3	23.4	12.4	12.8
Total excluding financial and personal	66.9	9.5	52.3	80.2	78.9	66.6
Grand Total	100.0					

TABLE 2: NEW AND INCREASED PROVISIONS AS A PERCENTAGE OF SECTORAL LENDING LEVELS

	Mean %	Standard Dev %	Max %	Correlation with GT	Correlation with TE
Agriculture	0.19	0.12	0.45	0.52	0.52
Mining & quarrying	0.25	0.36	1.5	-0.2	0.01
Construction	0.66	0.55	2.83	0.96	0.96
Food, drink & tobacco	0.20	0.19	0.83	0.75	0.72
Chemical & allied	0.23	0.28	1.15	0.09	0.11
Metal manufacture	0.23	0.27	1.29	0.64	0.64
Electrical engineering	0.43	0.30	1.11	0.71	0.77
Other engineering	0.58	0.60	2.84	0.33	0.41
Shipbuilding	0.88	1.2	5.84	-0.05	-0.01
Motor vehicles	0.43	0.50	1.91	0.28	0.30
Textiles, leather, clothing	0.71	0.52	1.97	0.60	0.64
Other manufacturing	0.55	0.44	1.95	0.65	0.72
Property companies	0.67	0.8	3.13	0.51	0.48
Transport & communication	0.73	1.0	6.10	0.8	
Central/local government	0.03	0.09	0.46	0.48	
Retail distribution	0.64	0.44	2.04	0.68	
Other distribution	0.44	0.31	1.27	0.74	
Insurance & pensions	0.09	0.24	1.3	-0.13	
Other financial	0.42	0.60	2.75	0.48	
Professional/ scientific/ miscellaneous	0.59	0.43	2.15	0.94	
House purchase	0.06	0.06	0.2	0.61	
Other personal	0.76	0.64	2.83	0.8	
Total excluding financial and personal (TE)	0.54	0.36	1.8	0.98	
Grand Total (GT)	0.49	0.30	1.62		

TABLE 3: WRITEOFFS AS A PERCENTAGE OF SECTORAL LENDING LEVELS

	Mean %	Standard Dev %	Max %	Correlation with GT	Correlation with TE
Agriculture	0.13	0.1	0.34	0.36	0.43
Mining & quarrying	0.2	0.43	2.39	0.03	0.11
Construction	0.53	0.49	2.61	0.95	0.91
Food, drink & tobacco	0.14	0.16	0.68	0.72	0.75
Chemical & allied	0.19	0.29	1.15	0.09	0.13
Metal manufacture	0.13	0.18	0.70	0.56	0.54
Electrical engineering	0.28	0.24	0.82	0.63	0.69
Other engineering	0.33	0.35	1.49	0.28	0.40
Shipbuilding	0.68	1.03	3.90	0.14	0.20
Motor vehicles	0.26	0.47	2.19	0.54	0.57
Textiles, leather, clothing	0.50	0.50	1.81	0.52	0.61
Other manufacturing	0.34	0.31	1.22	0.62	0.65
Property companies	0.59	0.78	3.65	0.56	0.48
Transport & communication	0.45	0.35	1.30	0.57	
Central/local government	0.04	0.18	0.04	0.43	
Retail distribution	0.45	0.35	1.54	0.55	
Other distribution	0.3	0.24	1.18	0.74	
Insurance & pensions	0.12	0.48	2.65	-0.09	
Other financial	0.26	0.29	1.15	0.63	
Professional/ scientific/ miscellaneous	0.39	0.31	1.65	0.92	
House purchase	0.05	0.07	0.25	0.43	
Other personal	0.34	0.34	1.69	0.89	
Total excluding financial and personal (TE)	0.37	0.27	1.41	0.98	
Grand Total (GT)	0.30	0.22	1.2		

TABLE 4: ANALYSIS OF FIRST DIFFERENCES

	Provisions		Writeoffs	
	Standard Dev %	Max %	Standard Dev %	Max %
Agriculture	0.09	0.2	0.07	0.13
Mining & quarrying	0.46	1.39	0.65	2.19
Construction	0.39	1.4	0.37	1.43
Food, drink & tobacco	0.14	0.3	0.13	0.37
Chemical & allied	0.42	1.11	0.45	1.15
Metal manufacture	0.32	1.25	0.24	0.62
Electrical engineering	0.22	0.51	0.25	0.66
Other engineering	0.74	2.4	0.25	0.92
Shipbuilding	1.4	5.2	1.28	3.67
Motor vehicles	0.65	1.73	0.64	2.17
Textiles, leather, clothing	0.57	1.47	0.59	1.6
Other manufacturing	0.43	1.02	0.41	1.16
Property companies	0.55	1.15	0.73	1.66
Transport & communication	0.99	5.15	0.44	1.1
Central/local government	0.11	0.46	0.21	0.54
Retail distribution	0.39	0.98	0.32	0.88
Other distribution	0.23	0.5	0.17	0.59
Insurance & pensions	0.37	1.3	0.64	2.55
Other financial	0.81	2.53	0.31	0.74
Professional/ scientific/ miscellaneous	0.24	0.78	0.2	0.7
House purchase	0.03	0.10	0.06	0.11
Other personal	0.25	0.99	0.19	0.52
Total excluding financial and personal (TE)	0.24	0.73	0.19	0.59
Grand Total (GT)	0.20	0.61	0.15	0.47

TABLE 5: TESTS FOR NORMALITY [$X^2(2)$]

	Write-offs		Provisions	
	linear	log	linear	log
Agriculture	2.9	2.5	2.0	4.0
Mining & quarrying	427.5	-	47.1	-
Construction	129.3	0.5	87.1	0.04
Food, drink & tobacco	17.8	1.9	27.3	2.0
Chemical & allied	59.2	2.6	28.0	-
Metal manufacture	38.9	-	65.9	-
Electrical engineering	2.9	2.7	3.7	1.3
Other engineering	28.7	1.3	54.9	0.8
Shipbuilding	49.0	0.1	107.5	-
Motor vehicles	148.8	-	13.3	-
Textiles, leather, clothing	11.6	1.3	4.4	2.3
Other manufacturing	10.7	1.1	11.4	0.9
Property companies	82.0	0.3	25.1	0.6
Transport & communication	7.1	0.8	701.2	4.1
Central/local government	524.4	-	255.9	-
Retail distribution	10.9	1.7	8.5	1.7
Other distribution	32.2	1.2	2.4	1.5
Insurance & pensions	923.5	-	506.3	-
Other financial	13.6	1.5	68.7	1.1
Professional/ scientific/ miscellaneous	100.9	0.4	36.1	0.5
House purchase	13.9	1.3	15.0	0.7
Other personal	131.0	16.8	43.9	2.6
Total excluding financial and personal	62.7	0.5	29.2	0.5
Grand Total	92.1	2.2	51.7	1.2

Critical value = 5.99

TABLE 6: STATIONARITY TESTS - LOG LEVELS

	Write-offs		Provisions	
	DF	ADF	DF	ADF
Agriculture	-1.6	-1.7	-3.7	-3.4
Mining & quarrying	-5.7	-5.1	-3.6	-3.0
Construction	-1.0	-1.4	-1.1	-1.2
Food, drink & tobacco	-2.7	-1.8	-3.3	-2.4
Chemical & allied	-4.7	-2.7	-7.9	-7.5
Metal manufacture	-0.7	-0.8	-3.6	-2.9
Electrical engineering	-2.1	-1.9	-2.3	-2.1
Other engineering	-2.6	-2.2	-3.2	-2.6
Shipbuilding	-3.8	-2.4	-3.1	-2.5
Motor vehicles	-3.5	-1.7	-2.9	-2.6
Textiles, leather, clothing	-4.0	-2.6	-3.6	-2.9
Other manufacturing	-3.2	-2.3	-2.7	-2.2
Property companies	-2.2	-2.1	-1.7	-1.4
Transport & communication	-3.1	-2.8	-1.6	-1.3
Central/local government	-3.6	-3.0	-3.5	-3.0
Retail distribution	-2.4	-2.2	-2.8	-2.8
Other distribution	-2.3	-2.0	-2.7	-2.4
Insurance & pensions	-3.3	-2.8	-3.4	-2.7
Other financial	-3.5	-3.8	-4.0	-2.2
Professional/ scientific/ miscellaneous	-1.1	-1.0	-1.3	-1.3
House purchase	-1.4	-1.4	-0.7	-1.2
Other personal	-0.9	0.1	-1.2	-0.6
Total excluding financial and personal	-1.1	-1.4	-2.0	-1.9
Grand Total	-0.9	-1.3	-2.3	-1.9

Critical value ≃ -2.9

TABLE 7: STATIONARITY TESTS - LOG DIFFERENCES

	Write-offs		Provisions		RESULTS: Write-offs	Provisions
	DF	ADF	DF	ADF		
Agriculture	-4.8	-5.3	-9.1	-4.0	D	L
Mining & quarrying	-3.8	-3.0	-6.7	-5.7	L	L
Construction	-4.3	-2.5	-4.8	-2.2	N	N
Food, drink & tobacco	-7.6	-7.1	-7.8	-3.9	D	D
Chemical & allied	-9.3	-5.4	-8.5	-10.0	D	L
Metal manufacture	-5.6	-3.7	-7.1	-5.2	D	L
Electrical engineering	-7.2	-3.8	-5.7	-3.5	D	D
Other engineering	-6.5	-4.5	-6.8	-3.7	D	D
Shipbuilding	-8.7	-5.2	-6.9	-5.4	D	D
Motor vehicles	-10.0	-3.8	-6.2	-4.2	D	D
Textiles, leather, clothing	-9.5	-7.8	-7.5	-4.7	D	L
Other manufacturing	-7.5	-5.4	-6.7	-3.4	D	D
Property companies	-5.5	-3.2	-6.7	-3.5	D	D
Transport & communication	-6.7	-4.8	-5.0	-2.1	D	N
Central/local government	-3.6	-3.0	-3.5	-3.0	L	L
Retail distribution	-5.8	-6.2	-5.3	-4.9	D	D
Other distribution	-6.0	-3.6	-6.3	-3.5	D	D
Insurance & pensions	-3.5	-2.9	-3.5	-2.8	D	D
Other financial	-6.0	-5.8	-9.2	-4.6	L	D
Professional/ scientific/ miscellaneous	-6.0	-3.2	-5.1	-1.9	D	N
House purchase	-5.3	-2.8	-4.3	-2.9	D	D
Other personal	-7.5	-4.2	-7.4	-5.8	D	D
Total excluding financial and personal	-4.9	-3.3	-5.6	-2.4	D	N
Grand Total	-5.0	-3.5	-6.7	-2.9	D	D

Critical value ≈ -2.9

Key

L = Levels stationary [I(0)]
D = Difference stationary [I(1)]
N = Not stationary [I(2+)]

TABLE 8: BETA COEFFICIENTS[a] (T VALUES) - LOG LEVELS

	Provisions		Write-offs	
Agriculture	1.0	(4.7)	0.5	(1.8)
Mining & quarrying	0.2	(0.4)	0.5	(1.1)
Construction	1.1	(9.8)	1.2	(12.1)
Food, drink & tobacco	1.3	(4.9)	1.0	(2.5)
Chemical & allied	0.9	(1.9)	1.5	(2.6)
Metal manufacture	1.0	(2.3)	1.2	(2.4)
Electrical engineering	1.1	(6.6)	0.8	(2.5)
Other engineering	1.1	(4.2)	0.8	(2.5)
Shipbuilding	0.6	(1.3)	0.9	(2.4)
Motor vehicles	1.4	(3.2)	1.4	(3.0)
Textiles, leather, clothing	1.0	(4.6)	1.0	(3.2)
Other manufacturing	1.1	(6.4)	0.9	(3.3)
Property companies	1.4	(4.3)	1.5	(4.8)
Transport & communication	1.2	(8.2)	0.8	(4.1)
Central/local government[b]	-	-	-	-
Retail distribution	1.0	(6.5)	0.8	(4.3)
Other distribution	1.1	(6.0)	0.8	(3.7)
Insurance & pensions	-	-	-	-
Other financial	1.6	(4.1)	1.2	(3.1)
Professional/ scientific/ miscellaneous	1.1	(10.9)	1.0	(9.6)
House purchase	0.9	(3.0)	1.1	(3.0)
Other personal	0.7	(4.3)	0.7	(5.3)
Total excluding financial and personal	1.2	(21.3)	1.1	(21.4)

(a) Coefficient on the grand total in the equation; log sectoral losses/sectoral loans = $\alpha + \beta$ grand total losses/grand total loans.

(b) Results not meaningful given missing observations.

TABLE 9: BETA COEFFICIENTS[a] (T VALUES) - LOG DIFFERENCES

	Provisions		Write-offs	
Agriculture	0.8	(4.6)	0.5	(1.7)
Mining & quarrying	-1.4	(2.0)	1.1	(1.0)
Construction	0.9	(6.3)	1.1	(9.6)
Food, drink & tobacco	1.1	(4.0)	0.7	(1.3)
Chemical & allied	-0.3	(0.1)	1.4	(1.2)
Metal manufacture	1.4	(2.2)	1.4	(1.7)
Electrical engineering	0.8	(3.5)	0.9	(1.7)
Other engineering	1.3	(4.4)	0.7	(2.0)
Shipbuilding	0.6	(1.0)	1.3	(2.1)
Motor vehicles	-0.4	(0.7)	1.1	(1.4)
Textiles, leather, clothing	1.0	(2.8)	1.1	(2.5)
Other manufacturing	0.9	(4.8)	1.2	(2.5)
Property companies	1.9	(7.3)	1.6	(5.1)
Transport & communication	1.0	(4.6)	0.4	(1.0)
Central/local govemment[b]	-	-	-	-
Retail distribution	0.7	(3.3)	1.0	(4.9)
Other distribution	0.7	(3.4)	0.8	(4.3)
Insurance & pensions[b]	-	-	-	-
Other financial	1.9	(2.8)	1.4	(2.0)
Professional/ scientific/ miscellaneous	0.7	(6.3)	0.9	(7.1)
House purchase	0.9	(4.9)	1.1	(4.7)
Other personal	0.6	(6.3)	0.9	(6.2)
Total excluding financial and personal	1.1	(25.6)	1.0	(27.6)

(a) Coefficient on the grand total in the equation; log sectoral losses/sectoral loans = $\alpha + \beta$ grand total losses/grand total loans.

(b) Results not meaningful given missing observations.

TABLE 10: SUMMARY: RESULTS FOR SECTORAL PERFORMANCE EXCEEDING PORTFOLIO AVERAGES

	Provisions			Write-offs			
	Mean	Standard Dev	Log Beta >1 (LorD)	Mean	Standard Dev	Log Beta >1 (LorD)	Memo: Mean Portfolio Share >5%
Agriculture							*
Mining & quarrying		*			*	D	
Construction	*	*	L	*	*	LD	*
Food, drink & tobacco			LD				
Chemical & allied					*	LD	
Metal manufacture			D			LD	
Electrical engineering			L		*		
Other engineering	*	*	LD	*	*		
Shipbuilding	*	*		*	*	D	
Motor vehicles		*	L		*	LD	
Textiles, leather, clothing	*	*		*	*	D	
Other manufacturing	*	*	L	*	*	D	
Property companies	*	*	LD	*	*	LD	*
Transport & communication	*	L	*	*	LD		
Central/local government							
Retail distribution	*	*		*	*		*
Other distribution		*	L		*		
Insurance & pensions					*		
Other financial		*	LD		*	LD	
Professional/ scientific/ miscellaneous	*	*	L	*	*	L	*
House purchase						L	*
Other personal	*	*		*	*	D	*
Total excluding financial and personal	*	*	LD	*	*	L	*

TABLE 11: RESULTS FOR SUBSAMPLE 1976-89

Provisions

	Levels:		Beta:		
	Mean	Sd	Max	Log level	Log difference
Construction	0.5	0.24	0.9	1.1	0.8
Property	0.5	0.63	2.8	1.9	1.5
Professional/ scientific/ miscellaneous	0.46	0.24	0.9	1.0	1.0
Total excluding financial and personal	0.43	0.21	0.8	1.3	1.1
Grand Total	0.39	0.14	0.6	-	-

Write-offs

	Levels:		Beta:		
	Mean	Sd	Max	Log level	Log difference
Construction	0.42	0.3	1.4	1.3	1.0
Property	0.56	0.8	3.7	1.8	1.6
Professional/ scientific/ miscellaneous	0.32	0.16	0.6	1.0	0.9
Total excluding financial and personal	0.31	0.16	0.7	1.1	1.1
Grand Total	0.25	0.12	0.6	-	

TABLE 12: LOSSES AS A PERCENTAGE OF TOTAL ADVANCES - PROVISIONS

	Mean%	Sd%	Mean + 2 Sd	Max%
Agriculture	0.012	0.007	0.026	0.032
Mining & quarrying	0.001	0.002	0.005	0.009
Construction	0.046	0.042	0.13	0.203
Food, drink & tobacco	0.004	0.003	0.01	0.011
Chemical & allied	0.003	0.006	0.015	0.03
Metal manufacture	0.001	0.001	0.003	0.005
Electrical engineering	0.009	0.006	0.021	0.024
Other engineering	0.028	0.04	0.108	0.208
Shipbuilding	0.002	0.003	0.008	0.014
Motor vehicles	0.003	0.005	0.013	0.018
Textiles, leather, clothing	0.013	0.010	0.033	0.04
Other manufacturing	0.022	0.018	0.058	0.075
Property companies	0.054	0.076	0.206	0.265
Transport & communication	0.013	0.018	0.049	0.105
Central/local government	0.00001	0.00001	0.00021	0.001
Retail distribution	0.041	0.027	0.095	0.107
Other distribution	0.022	0.015	0.052	0.063
Insurance & pensions	0.00003	0.001	0.00203	0.007
Other financial	0.005	0.008	0.021	0.038
Professional/scientific/ miscellaneous	0.085	0.078	0.241	0.395
House purchase	0.007	0.008	0.023	0.039
Other personal	0.115	0.085	0.285	0.361
Total excluding financial and personal	0.360	0.241	0.842	1.199
Grand Total	0.487	0.304	1.095	1.615
Annualised	0.974	-	2.19	3.23
Sum of Subtotals	0.487	-	1.40	2.05
Annualised	0.974	-	2.80	4.10

TABLE 13: LOSSES AS A PERCENTAGE OF TOTAL ADVANCES - WRITE-OFFS

	Mean%	Sd%	Mean + 2 Sd	Max%
Agriculture	0.008	0.005	0.018	0.017
Mining & quarrying	0.001	0.001	0.0021	0.008
Construction	0.037	0.039	0.115	0.187
Food, drink & tobacco	0.002	0.002	0.006	0.008
Chemical & allied	0.002	0.005	0.012	0.028
Metal manufacture	0.0001	0.001	0.0021	0.005
Electrical engineering	0.005	0.005	0.015	0.015
Other engineering	0.012	0.013	0.038	0.058
Shipbuilding	0.002	0.003	0.008	0.013
Motor vehicles	0.002	0.003	0.008	0.019
Textiles, leather, clothing	0.008	0.007	0.022	0.031
Other manufacturing	0.013	0.013	0.039	0.061
Property companies	0.042	0.058	0.158	0.222
Transport & communication	0.009	0.007	0.02	0.032
[5~Central/local government	0.00001	0.00001	0.00003	0.003
Retail distribution	0.028	0.021	0.070	0.083
Other distribution	0.014	0.012	0.038	0.058
Insurance & pensions	0.00001	0.0003	0.00061	0.001
Other financial	0.003	0.004	0.011	0.018
Professional/scientific/ miscellaneous	0.055	0.056	0.167	0.303
House purchase	0.005	0.6	0.125	0.03
Other personal	0.05	0.042	0.134	0.216
Total excluding financial and personal	0.243	0.179	0.601	0.938
Grand Total	0.301	0.222	0.745	1.196
Annualised	0.602	-	1.49	2.392
Sum of Subtotals	0.301	-	1.013	1.416
Annualised	0.602	-	2.026	2.832

TABLE 14: AUTOREGRESSIVE LAG COEFFICIENTS -PROVISIONS - LEVELS (* SIGNIFICANT AT 95%)

	Constant		Lag 1		Lag 2		Lag 3	
Agriculture	0.0005	(1.6)	0.55	(2.6)*	0.48	(2.0)*	-0.23	(1.0)
Mining & quarrying	0.002	(2.3)*	0.29	(1.5)	-0.35	(1.8)	0.16	(0.8)
Construction	0.003	(1.6)	0.68	(3.1)*	0.91	(3.3)*	-0.99	(3.3)*
Food, drink & tobacco	0.008	(1.6)	0.71	(3.3)*	0.24	(0.8)	-0.3	(9.0)
Chemical & allied	0.004	(3.4)*	-0.14	(0.7)	-0.2	(1.0)	-0.16	(0.8)
Metal manufacture	0.002	(1.9)	0.3	(1.6)	0.025	(0.1)	-0.22	(0.6)
Electrical engineering	0.002	(1.9)	1.0	(4.9)*	-0.34	(1.2)	0.03	(0.1)
Other engineering	0.004	(2.0)*	0.22	(1.1)	0.06	(0.3)	0.05	(0.3)
Shipbuilding	0.005	(1.6)	0.37	(1.9)	-0.15	(0.7)	0.22	(1.1)
Motor vehicles	0.004	(2.5)*	0.13	(0.7)	0.03	(0.1)	-0.04	(0.2)
Textiles, leather, clothing	0.002	(1.2)	0.23	(1.1)	0.3	(1.5)	0.23	(1.1)
Other manufacturing	0.003	(2.0)*	0.43	(2.1)*	0.33	(1.5)	-0.18	(0.9)
Property companies	0.003	(2.9)*	0.26	(1.3)	0.33	(1.7)	-0.29	(1.9)
Transport & communication	-0.00003	(0.7)	1.1	(1.6)	1.3	(1.7)	-1.1	(1.5)
Central/local government	0.0002	(1.0)	0.2	(1.1)	0.05	(0.2)	0.53	(2.6)*
Retail distribution	0.002	(1.5)	0.59	(2.7)*	-0.39	(0.1)	0.14	(0.5)
Other distribution	0.001	(1.2)	0.7	(2.9)*	0.2	(0.9)	-0.06	(0.3)
Insurance & pensions	0.001	(1.9)	-0.14	(0.7)	-0.11	(0.5)	-0.07	(0.4)
Other financial	0.004	(2.0)*	0.07	(0.3)	0.07	(0.3)	0.02	(0.1)
Professional/scientific/ miscellaneous	0.002	(2.1)*	1.1	(6.0)*	0.6	(2.4)*	-0.88	(4.8)*
House purchase	0.0001	(1.4)	0.96	(3.6)*	0.43	(1.4)	-0.56	(2.7)*
Other personal	-0.001	(1.3)	1.2	(6.3)*	-0.3	(1.1)	0.48	(1.7)
Total excluding financial and personal	0.0022	(2.3)*	0.79	(4.2)*	0.74	(3.1)*	-0.93	(4.2)*
Grand Total	0.002	(1.9)*	0.86	(4.4)*	0.63	(2.5)*	-0.89	(3.5)*

TABLE 15: ANALYSIS OF INDUSTRIAL SECTORS - PROVISIONS

	Mean	Standard dev	Mean +2sd	Maximum	Beta (t) log level		log differences	
Primary	0.43	0.36	1.2	1.9	1.1	(13.1)	0.9	(8.5)
Manufacturing	0.48	0.31	1.1	1.2	1.1	(6.6)	1.1	(7.0)
Financial	0.56	0.42	1.4	2.1	1.1	(10.8)	0.8	(6.8)
Services	0.61	0.42	1.4	1.9	1.2	(10.1)	1.3	(12.0)
Personal	0.38	0.26	0.9	1.3	0.6	(4.6)	0.6	(7.6)
Memo: portfolio	0.49	0.3	1.1	1.6				

Note: Definitions; Primary sector includes agriculture, mining and construction; services, property retail, other distribution, transport and central/local government; personal house purchase and other personal; financial insurance, other financial and miscellaneous, manufacturing the other categories.

TABLE 16: BETA COEFFICIENTS OVER SUBSAMPLES - PROVISIONS

	Full sample		1976-83		1984-91	
	levels	differences	levels	differences	levels	differences
Primary	1.1	0.9	0.9	0.8	1.3	1.2
Manufacturing	1.1	1.1	1.3	1.1	0.9	0.8
Financial	1.1	0.8	1.0	0.7	1.2	1.0
Services	1.2	1.3	1.2	1.3	1.4	1.6
Personal	0.6	0.6	0.4	0.6	0.7	0.7

TABLE 17: ECONOMETRIC EQUATIONS FOR PROVISIONS

half yearly data 1976 H2 - 1991 H2

Key	PROV	=	New and increased provisions	TC	=	Number of extant companies
	BS	=	Balance-sheet total	KB	=	Stock of company bank borrowing
	RR	=	Real interest rate	KS	=	Capital stock at current replacement cost
	GDP	=	Real GDP			
	CL	=	Company liquidations	WO	=	Write-offs

Cointegrating vector

$$\ln\left(\frac{PROV}{BS}\right) = \underset{(3.7)}{3.4} + \underset{(4.5)}{0.0034}RR - \underset{(3.9)}{14.0}\Delta\ln GDP + \underset{(9.2)}{1.7}\ln\left(\frac{CL}{TC}\right) + \underset{(2.4)}{0.73}\ln\left(\frac{KB}{KS}\right)$$

$\bar{R}^2 = 0.8$, se = 0.24, DW = 2.6, DF = -7.3, ADF = -3.4

Dynamic Equation

$$\Delta\ln\left(\frac{PROV}{BS}\right) = \underset{(2.9)}{0.3} + \underset{(3.2)}{0.0017}\Delta RR - \underset{(3.0)}{15.3}\Delta\ln GDP + \underset{(4.8)}{1.93}\Delta\ln\left(\frac{CL}{TC}\right) - \underset{(1.6)}{0.46}RES_{t-1} - \underset{(3.4)}{0.57}\Delta\ln\left(\frac{PROV}{BS}\right)_{t-1}$$

$\bar{R}^2 = 0.78$, se = 0.23, DW = 1.5, LM(2) = 4.1, RESET(1) = 0.03, NORM(2) = 1.8, HETERO(1) = 1.9, CHOW(4) = 3.8

Forecasting performance (for equation estimated up to 1989 H2)

		Actual	Predicted
90	H1	0.61	0.42
	H2	0.82	0.59
91	H1	0.02	0.33
	H2	0.41	0.28

TABLE 18: EQUATION FOR WRITE-OFFS (DEPENDENT VARIABLE, LOG OF DIFFERENCE OF WRITE-OFFS AS A PROPORTION OF ASSETS)

Variable definitions as per Table 21

	(1) 1979H2 - 1989H2	(2) 1979H2 - 1991H2
Constant	-0.24	-0.33
	(1.8)	(3.0)
ΔlnPROV/BS	0.57	0.92
	(2.1)	(5.1)
ΔlnPROV/BS$_{t-4}$	0.31	0.21
	(1.9)	(1.4)
ΔlnPROV/BS$_{t-5}$	0.25	0.31
	(1.6)	(2.0)
lnPROV/WO$_{t-1}$	-0.34	-0.54
	(1.7)	(3.7)
$\bar{R}^2$	0.49	0.66
se	0.27	0.27
DW	2.2	1.8
LM(2)	3.4	0.7
RESET(1)	3.3	0.4
NORM(1)	0.8	0.1
HETERO(1)	0.4	0.1
CHOW(4)	4.4	-

Forecasts from equation (1)

		Actual	Predicted
1990	H1	0.96	0.46
	H2	1.04	0.44
1991	H1	0.25	-0.04
	H2	0.50	0.14

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