THE EFFECT OF MACROECONOMIC CONDITIONS ON BANKS' RISK AND PROFITABILITY

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Abstract

This paper examines the overall variability of Australian banks' credit risk during the 1990s. It assesses the extent to which this overall variability can be explained by variability in the level of banks' aggregate credit risk over time, or alternatively, by variation in the average credit risk of different banks. The ability of macroeconomic variables to explain movements in bank risk is also considered. Discussion of banks' credit risk is supplemented with analysis of the rate of return on assets earned by banks since the 1960s. While most of the variability in banks' credit risk and profitability is due to differences between banks, macroeconomic variables are found to exert a strong influence on banks' risk and profitability. The share of interest payments in the corporate and household sectors' income, real credit growth and property prices are most strongly correlated with banks' risk and profitability.

JEL Classification Numbers: G21, G28
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1. Introduction

The principal source of banking fragility is credit risk: the risk of loss resulting from counterparty default. This paper compares the relative contributions of interbank variation and the variation through time to the overall variability in Australian banks' credit risk. A simple model, which imposes the constraint that each bank responds to macroeconomic developments in the same way, is used to examine the ability of macroeconomic variables to explain movements in individual banks' risk. Since consistent data on banks' credit risk are only available since 1990, discussion of banks' credit risk during the 1990s is supplemented with analysis of the rate of return on assets earned by banks since the 1960s.

While most of the variability in banks' credit risk and profitability is due to differences between banks, macroeconomic variables are found to exert a strong influence on each bank's risk and profitability. In particular, the share of interest payments in the corporate and household sectors' income, real credit growth and property prices are most strongly correlated with banks' risk and profitability.

These findings offer support to three strands of theoretical analysis of the interaction between financial institutions and the real economy. Firstly, the effect of real credit growth on banks' credit risk and profitability is in line with the view that difficulties in monitoring bank performance can lead banks to weaken their credit standards in times of rapid expansion of aggregate credit. Secondly, the observed relation between property prices and bank risk supports the proposition that the difficulties banks have in monitoring borrowers' viability (and the effect of collateral values in signalling borrower credit worthiness) play an important role in determining the supply of credit. Thirdly, our results are consistent with theoretical analysis suggesting that cyclicality in agents' preferences for gearing is an important influence on bank risk and profitability.

The following section discusses the potential sources of variation in banking risk and profitability. The third section presents an analysis of banks' credit risk during the 1990s. A longer-run analysis of bank profitability is presented in the fourth section. Section five concludes.

2. Sources of Variation in Banking Risk and Performance

2.1 Variation Between Banks

Differences between banks in risk exposure and profitability arise from two broad sources: the different operating strategies that banks choose to adopt and the efficiency achieved by each institution.

Each bank's operating strategy has three main elements: its scale, the scope of its operations and its risk appetite. A significant body of empirical work suggests that the scale economies in banking are not large, thus performance is not strongly related to the scale of each bank's operations (Calomiris and Karceski 1998). Nevertheless, differences across banks in the scale of their operations will result in different levels of diversification and thus different levels of riskiness.

Economies of scope present a trade-off between the benefits of specialisation (for example, a simple product range allows for ease of administration) and the benefits from diversification and cross-selling. In seeking to maximise efficiency in making loans and related customer-servicing activities, banks tend to focus on areas where they believe they have a comparative advantage (Allen 1997). This leads to concentrations by geography, industry, demographics and other market characteristics. Such differences in the scope of banks' activities will lead to differences in bank riskiness and profitability as economic conditions vary across different regions and industrial sectors.

While the scale and scope of operations of each bank will influence its overall risk, banks may also separately manage their risk profile. The development of financial techniques such as securitisation, credit derivatives and other financial derivatives has enhanced banks' capacity to determine their risk profile independent of their underlying business activities (Basel Committee on Banking Supervision 2000).

The ability of managers to achieve efficient use of inputs will influence the dispersion in risk and performance across banks. In particular, inefficient institutions have a tendency to carry higher risk (Eisenbeis, Ferrier and Kwan 1999). This may be because poor management quality results in both poor resource and risk management. Alternatively, individual institutions may attempt to compensate for their inefficiency by taking on greater risk.

There is an extensive literature that seeks to identify which individual-bank factors best predict bank performance. Since the bulk of this research has been carried out in the US (with its large population of banks and long history of bank failures), the work mostly focuses on modelling the likelihood of bank failure. In this work, capital adequacy, earnings and impaired assets are found to be the most useful indicators of the probability of failure (Demirgüc-Kunt 1989). In addition, rapid expansion of lending activities tends to increase risk (Keeton 1999). More elaborate modelling, which distinguishes between the likelihood of failure and time to failure, finds that basic indicators of a bank's condition such as capital, net income and impaired assets are also important determinants of the timing of bank failure (Cole and Gunther 1995).

A number of studies compare the effects of individual-bank risk-taking and macroeconomic conditions on the likelihood of bank failure. Emmons (1993), when considering US banking failures, concludes that increased risk-taking at individual banks alone does not fully account for the observed pattern of bank failures. Local economic conditions are also important predictors of bank failure. It is the coincidence of risky bank portfolios and difficult economic conditions that makes bank failure most likely.

González-Hermosillo, Pazarbaşioğlu and Billings (1997), in their study of the 1994 Mexican financial crisis, refine the distinction between the effect of bank-specific and economy-wide factors on the likelihood of bank failure. They find that factors determining the likelihood of failure differ from those determining the timing of failure. Bank-specific variables, in combination with aggregate banking sector factors help to explain the likelihood of bank failure, while macroeconomic factors play a pivotal role in influencing the time of failure. In Mexico, high real interest rates, exchange rate depreciation and an increase in the overall gearing of the economy triggered bank failures.

2.2 System-wide Variation

While each bank, on its own, can choose to take on more or less risk by changing its own behaviour, its riskiness and performance will also be influenced by developments in the aggregate supply and demand for loan finance. On the demand side, banks may become more risky because either borrowers put more risky projects forward for bank finance or the amplitude of the economic cycle may, unexpectedly, increase. On the supply side, the behaviour of individual banks may become more risky due to industry-wide developments, such as changes in regulation and the level of competition in the banking market.

One widely used measure of credit risk is the ratio of impaired assets to total on-balance sheet assets.[1] Figures 1 and 2 compare the movement in the industry-average impaired assets ratio during the 1990s with movements in a number of macroeconomic variables that influence loan supply and demand.[2] Following the unravelling of the credit boom of the late 1980s the overall level of Australian banks' impaired assets increased sharply in 1990 and 1991, reaching a peak in 1992. As banks wrote down the value of their bad loans the impaired assets ratio declined sharply. Subsequently, as the underlying condition of borrowers recovered, the ratio fell more gradually up until late 1997. Over the last few years, the industry-average impaired assets ratio has remained roughly constant at 0.7 per cent.

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1 Following the definition specified by the Australian Prudential Regulation Authority (APRA), impaired assets are taken to be the sum of non-accrual items, restructured items and assets acquired through security enforcement (for more details see Reserve Bank of Australia (1995)). The Reserve Bank revised asset quality measurement and reporting arrangements in September 1994. Prior to that, impaired assets were taken to be the sum of non-accrual items and accrual items in arrears 90 days and longer. Tests for a structural break in the data associated with the change in reporting arrangements find that the break is not statistically significant.

2 Definitions of these macroeconomic variables are presented in Appendix A.

Figure 1: Banks' Impaired Assets and the Macroeconomy

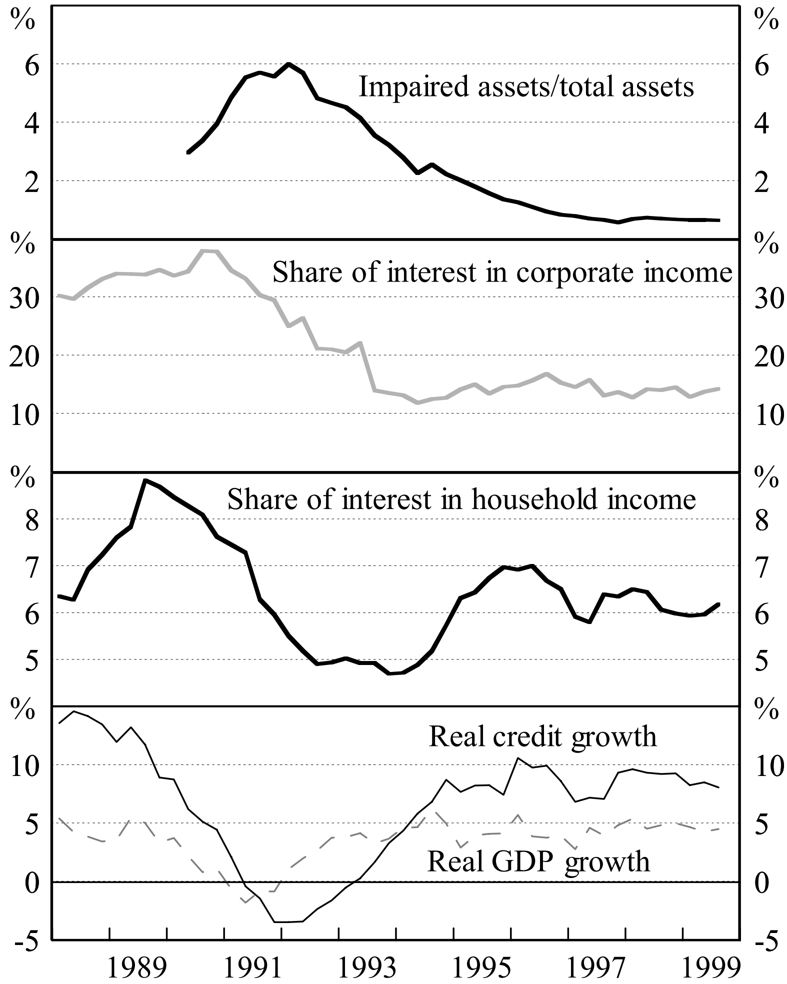
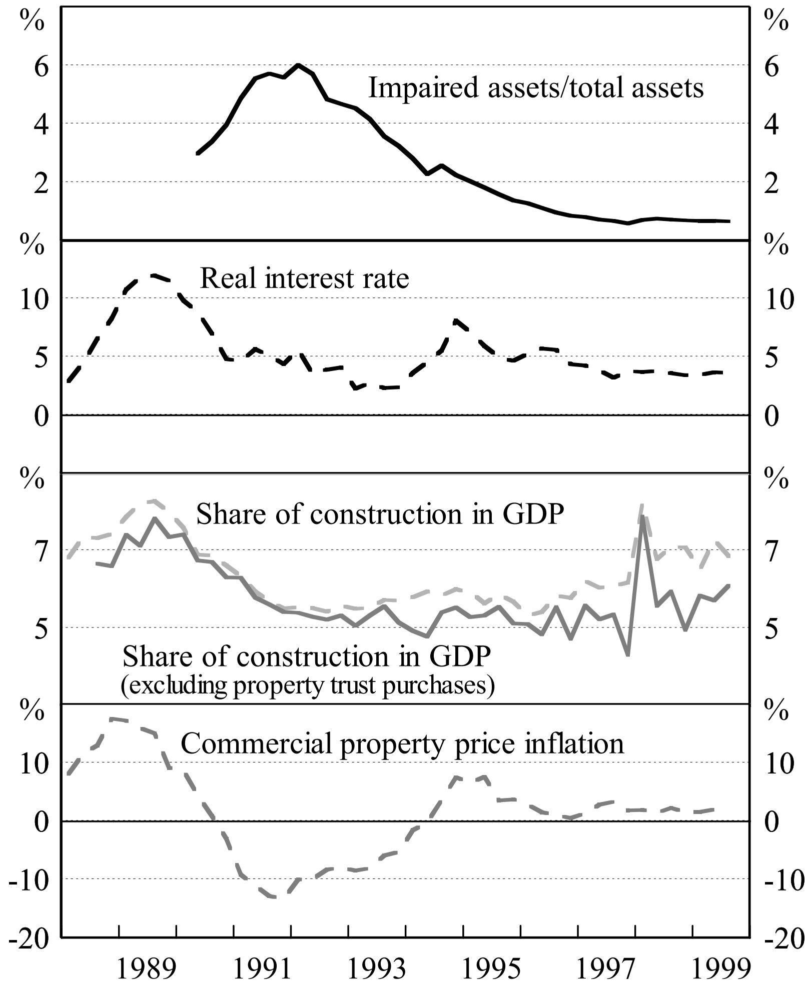


Figure 2: Banks' Impaired Assets and the Macroeconomy



2.2.1 The demand for loan finance

Many studies show that bank performance is correlated with the business cycle (Lowe and Rohling 1993; Kaufman 1998). Firms' ability to service debt is most directly determined by their income, their gearing and the level of interest rates. In the first instance, the ability of firms to meet their debt obligations depends upon the share of their income taken up by interest payments. In Australia, the share of interest payments in corporate income and household income fell steadily over the first few years of the 1990s. In the latter half of the decade growth in corporate debt has been offset by lower interest rates, leaving the share of interest in income roughly unchanged. In contrast, the gearing of the household sector has grown more strongly since 1994. The peaks in the share of interest payments in household income coincided with peaks in interest rates in 1989 and late 1994.

All else equal, growth in aggregate income and output will strengthen firms' ability to meet their debt obligations. Calomiris, Orphanides and Sharpe (1997) outline three factors that exacerbate non-financial firms' sensitivity to cycles in aggregate activity: information asymmetries between borrowers and financiers; the advantages of investing during periods of rapid growth; and firms' tendency towards excessive optimism. These factors suggest that non-financial firms' performance (and banks' credit risk, in turn) will depend upon both the level and the rate of growth of aggregate activity.

Firstly, firms that rely on debt to expand their operations aggressively during periods of rapid economic growth are likely to be the least creditworthy when recession strikes. In the presence of information asymmetries between the managers and financiers of firms, debt contracts can go some way towards aligning managers' incentives with financiers' interests. This has the potential to reduce moral-hazard driven behaviour by firm management, adverse selection and monitoring costs. The firms that rely on debt (rather than equity) finance, therefore, are likely to be those for which asymmetric information problems are the most pronounced. These firms are likely to be most susceptible to slowdowns in economic growth.

Secondly, theoretical models of optimal investment strategies suggest that there are advantages in expanding rapidly. For example, Murphy, Shleifer and Vishny (1989) posit that growth in one sector of the economy has spillover effects by increasing demand for other sectors' output. Such considerations emphasise the advantages of investing during periods of rapid economic growth.

Thirdly, Calomiris *et al* (1997) argue that firms may not properly anticipate how aggregate economic circumstances may affect the value and liquidity of their assets. As a result, firms may have a tendency to be excessively optimistic regarding their ability to avoid financial distress and therefore, take on excessive leverage during periods of economic expansion. This view is in line with Minsky (1995) who characterises economic cycles as being driven by euphoric over-expansion of credit. Over a run of good times (characterised by minor cycles in economic activity) firms' and households' balance sheets change so that ever-larger proportions of their gross cash flows are committed to debt service. That is, preferences for leverage follow a cyclical pattern.

These three arguments suggest that, in the short term, stronger output growth will reduce banks' impaired assets, although over longer horizons this relationship may work in the opposite direction, with an acceleration in output growth leading to higher impaired assets. The sharp contraction in economic output in 1990–1991 coincided with the rise in impaired assets, whilst the sustained real growth of around 4 per cent since 1992 has been associated with the steady decline in impaired assets.

In Australia, there is a long history of slumps in building activity leading to banking problems (Kent and Lowe 1997). As the share of activity taken up by construction grows, therefore, the economy's overall credit quality is likely to decline. Particularly during the early 1990s a large proportion of banks' problem loans were associated with the financing of commercial property. The sharp peak in the share of construction in GDP in early 1990 led the peak in impaired assets. The spike in construction activity in 1998 was not, however, reflected in an increase in impaired assets. This reflected, in part, the fall in the share of commercial property finance provided by banks as listed property trusts took on a greater role.

Diamond (1991) suggests that real interest rates influence companies' choice between risky and safe projects. Low real interest rates increase the present value of firms' future profits. Since choosing more risky projects would put that future return at risk, as the expected future value of the company rises, the incentive to adopt low-risk projects increases. Thus, lower real interest rates are predicted to reduce the likelihood of default. This, in turn, reduces the riskiness of banks' loan portfolios. While the peak in the real interest rate preceded the rise in impaired assets in 1991 by more than a year, the increase in the real interest rate in 1994 was not associated with a commensurate rise in impaired assets.

Several recent studies (which are surveyed in Laker (1999)) have sought to identify those macroeconomic variables that best predict system-wide banking crises. Consistent with the arguments discussed above, the variables most often found to be associated with a high probability of banking crisis are low output growth, high real interest rates and strong credit growth.

2.2.2 The supply of loan finance

Supply-side developments also influence banks' riskiness and performance. Chief among these factors are agency costs, the regulatory environment, the competitiveness of the banking market and incentives for herding behaviour amongst banks.

The credit risk on any individual loan can be broken down into two components: the probability that the borrower will default, and the losses incurred in the event of default. The principal determinant of the losses incurred in the event of default is the value of security held as collateral against bank debt. Asset price deflation, by eroding the collateral against which banks lend, heightens financial institutions' vulnerability to borrowers' defaults. Reduced collateral values increase adverse selection problems as banks try to distinguish between sound and unsound borrowers. Increases in asset prices, by increasing the perceived collateral of potential borrowers, make financial institutions willing to supply a greater volume of funds at any given interest rate (Kiyotaki and Moore 1997). In Australia, the collateral for most loans is real estate. The collapse in commercial property prices in 1990–1991 was associated with the sharp increase in impaired assets. The subsequent recovery in commercial property prices has coincided with the steady improvement in the banks' impaired assets position.

Regulatory constraints, both prudential controls and those aimed at influencing macroeconomic activity, may directly constrain banks' risk-taking. Financial deregulation in Australia during the 1980s saw banks expand into areas that they previously would not have entered. There was both a rapid expansion of credit and a lowering of credit standards applied by banks (Macfarlane 1991). The Australian experience mirrored that of other countries that undertook similar programs of deregulation, most notably the Scandinavian countries, but also the US and UK. During the 1990s, however, the changes in the Australian banking industry's operating environment were less marked.

Changes in the level of competition within the banking market (particularly when driven by deregulation) may also generate system-wide movements in riskiness and performance. For instance, a more competitive environment may prompt individual institutions to seek to capture greater market share. While such expansion may be viable for one institution acting in isolation, when all banks behave in the same way such expansion sees increased lending to more marginal, risky borrowers (Drake and Llewellyn 1997). More generally, increased competition may also erode super-normal profits thus making banks' profits more sensitive to the underlying riskiness of their loan portfolios.

There are a number of models that suggest that it may be optimal for banks to adopt herding-type behaviour. Rajan (1994) provides one such model that links herding behaviour with cycles in credit growth and credit quality. This model is based on two stylised facts. Firstly, the market is seen to regard an individual bank's poor performance more leniently when the entire banking sector has been hit by an adverse shock. Thus there is an incentive for each to adjust its credit policy in line with other banks in the market. Secondly, a liberal credit policy, on the part of an individual bank, will boost current earnings at the expense of future earnings. Poor quality borrowers will meet their repayment obligations for at least a short time before becoming unable to service their loan obligations. Since in the short term expanding lending boosts earnings, the banks have an incentive to ease their credit standards in times of rapid credit growth (and likewise, to tighten standards when credit growth is slowing).

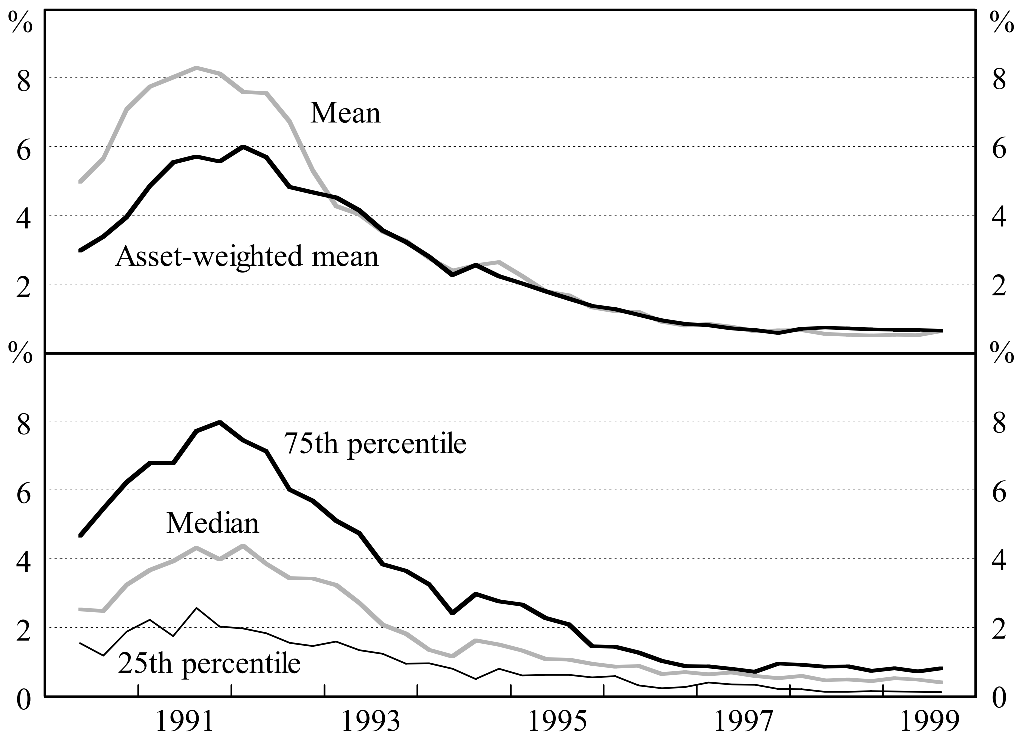
In the short term, increased credit growth, by adding to banks' total assets without immediately increasing impaired assets, would be expected to reduce the impaired assets ratio. Over the longer term, however, it would be expected that rapid credit growth, by increasing lending to more marginal borrowers, would lead to increases in the impaired assets ratio. The rapid credit growth of the late 1980s preceded the Australian banks' loan loss problems of 1990–1992. Since then, however, strong credit growth has accompanied the steady improvement in the impaired assets ratio.

3. Australian Banks' Impaired Assets During the 1990s

3.1 A Simple Comparison of Firm-specific and System-wide Variation

Figure 3 shows the mean, median and the 25th and 75th percentiles of the distribution of impaired assets ratios across all banks each quarter.[3] The unweighted mean is more variable than the asset-weighted mean. This reflects the fact that the impaired assets ratios of smaller banks tend to be more variable than the larger banks. The foreign-owned banks with small asset bases within Australia experienced particularly high levels of impaired assets between 1990 and 1992.

Figure 3: The Distribution of Banks' Impaired Assets Ratios



The movement of the 25th and 75th percentiles show that between 1990 and 1992 the dispersion across banks rose considerably. The spread between the 25th and 75th percentiles almost doubled between June 1990 and March 1992, rising from 3.1 percentage points to 5.9 percentage points. Over this period the weakest banks became comparatively weaker. Exits from the industry and the overall

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3 The sample includes both Australian-owned banks and locally incorporated subsidiaries of foreign banks. Foreign bank branches, however, are excluded.

improvement in banks' credit risk exposure have seen the interquartile range narrow to 0.7 percentage points by September 1999. With this narrowing of the distribution, the differences between smaller and larger banks has also narrowed; there being almost no difference between the asset-weighted and unweighted means since 1993.

The distinction between variation across banks and variation through time can be made more precise by decomposing the variance of the full panel of data. The data are quarterly for the period June 1990 to September 1999. The panel is unbalanced. Of the 35 banks included in the sample, 16 reported impaired assets data continuously throughout the full sample period. The remainder includes banks that entered the Australian banking market, were taken over, or converted to foreign bank branch status during the decade. A full list of the banks included and the period over which they reported impaired assets data are presented in Appendix A.

Standard analysis of variance techniques break down the total panel variation into variation due to differences between banks, variation through time and a residual variance using the calculations shown in Table 1 (Croxton, Cowden and Klein 1967).

Table 1: Analysis of Variance

Variation between banks	$\sum_{i} N_i \left(\overline{x}_i - \overline{x}\right)^2$
Variation through time	$\sum_{t} N_t \left(\overline{x}_t - \overline{x}\right)^2$
Residual	$\sum_{i,t} \left(x_{it} + \overline{x} - \overline{x}_i - \overline{x}_t\right)^2$
Total variation	$\sum_{i,t} \left(x_{it} - \overline{x}\right)^2$

Where: $\overline{x}_i$ is the mean of all observations for bank i
N_i is the number of observations for bank i
$\overline{x}_t$ is the mean across banks at time t
N_t is the number of banks in the sample at time t
$\overline{x}$ is the sample-wide mean

Table 2 shows the proportion of the total panel variation accounted for by the variation between the impaired assets ratio's mean level across banks and the ratio's mean level across time. The decomposition is presented on two bases: the first is a simple unweighted basis; the second weights the impaired assets ratios by each bank's share in total bank assets. In both cases most of the variation in the panel is due to differences between banks, although the variation through time also accounts for a substantial share of the total panel variation. When the asset-share weights are applied, the variability across banks declines (both in absolute terms and as a share of the total panel variation), indicating that small banks tend to be more widely dispersed around the industry average. The variation across time is also lower when weighted by each bank's asset share than on an unweighted basis, reflecting the fact that smaller banks' impaired assets ratios tend to be more variable through time.

Table 2: Decomposition of Variance
Share of total variance, per cent
Panel sample: June 1990–September 1999

	Banks	Time	Residual
Unweighted	69.4	18.8	11.8
Asset-weighted	59.1	8.1	32.8

3.2 Regression Analysis

To more precisely measure the extent to which the macroeconomy influences variation through time in banks' impaired assets ratios, we conduct panel regression analysis. The results for four models are summarised in Table 3. In each case, a fixed-effects model including first-order auto regression is estimated taking each bank's impaired assets ratio as the dependent variable.[4]

Since Australia has seen few banking failures, it is not possible to replicate the empirical studies of firm-specific determinants of bank failure surveyed in

[4] Pre-testing of the data suggests that the impaired assets ratio is stationary (around a trend). At any rate, given the relatively small number of time series observations (38 quarters), our inference is confined to consideration of short-term dynamics rather than longer-term relationships.

Table 3: Impaired Assets and the Macroeconomy

Dependent variable: impaired assets/total assets

Panel sample (quarterly data): June 1990–September 1999

Independent variable	**Coefficient**	**Independent variable**	**Coefficient**
Model 1		Model 2	
Trend_t	–0.00044** (0.00023)	Trend_t	–0.00037** (0.00023)
Impaired assets/total assets_{t-1}	0.826*** (0.018)	Impaired assets/total assets_{t-1}	0.829*** (0.018)
Share of interest in corporate income_{t-5}	0.072*** (0.018)	Share of interest in corporate income_{t-5}	0.064*** (0.019)
Share of interest in household income_{t-5}	0.195* (0.156)	Share of interest in household income_{t-5}	0.214* (0.157)
Real credit growth_{t-3}	0.287*** (0.062)	Real credit growth_{t-3}	0.204*** (0.071)
		Real GDP growth_t	–0.107* (0.083)
		Real interest rate_{t-4}	0.054** (0.031)
Adjusted R-squared	0.9437	Adjusted R-squared	0.9440
Akaike's information criteria	–1229.9	Akaike's information criteria	–1232.8
Model 3		Model 4	
Trend_t	–0.00082*** (0.00025)	Trend_t	–0.00060*** (0.00024)
Impaired assets/total assets_{t-1}	0.828*** (0.018)	Impaired assets/total assets_{t-1}	0.828*** (0.018)
Share of interest in corporate income_{t-5}	0.039** (0.021)	Share of interest in corporate income_{t-5}	0.049** (0.021)
Share of interest in household income_{t-5}	0.391*** (0.165)	Share of interest in household income_{t-5}	0.285** (0.160)
Real credit growth_{t-3}	0.132** (0.078)	Real credit growth_{t-3}	0.203*** (0.072)
Commercial property price inflation_{t-3}	–0.061* (0.045)	Commercial property price inflation_{t-3}	–0.026 (0.043)
Share of construction in GDP_{t-4}	0.396*** (0.109)	Share of construction (excluding property trust purchases) in GDP_{t-4}	0.278*** (0.099)
Adjusted R-squared	0.9444	Adjusted R-squared	0.9441
Akaike's information criteria	–1239.3	Akaike's information criteria	–1234.0

Notes: The models are estimated using ordinary least squares including bank-specific fixed effects. Figures in parentheses show the standard error of the coefficient estimate. ***, **, * denote significance at the 1, 5 and 10 per cent levels respectively.

Section 2.1. In focusing on the effect of the macroeconomic cycle on banks, effects are captured by the bank-specific fixed effects, which capture differences between the average level of each bank's impaired assets.

Application of the Hausman specification test rejected the random-effects model in favour of the fixed-effects model at a one per cent significance level. A fixed effects model is a natural choice since our estimation sample is identical to the population of interest (Judge *et al* 1988). Our sample includes all banks incorporated in Australia rather than a random sample from the population of Australian financial institutions.[5]

The fixed-effects model assumes that interbank differences are constant through time and each bank's impaired assets ratio will respond in the same way to movements in macroeconomic variables. Figure 1 shows these assumptions are unlikely to hold in practice, suggesting estimated coefficients are likely to understate the response of smaller institutions and overstate the response of larger institutions. The simple, fixed-effects approach is, however, given empirical support by the absence of significant heteroscedasticity in the residuals from our estimated models.[6]

A lagged dependent term and trend are included in each model. The impaired assets ratio exhibits quite strong autocorrelation. Thus, shocks to the level of impaired assets are seen to be quite persistent. This is borne out in the impulse response functions shown in Figure 4, which show the response of impaired assets, predicted by each model, to a one-standard deviation shock in each independent variable. The trend term is also highly significant.

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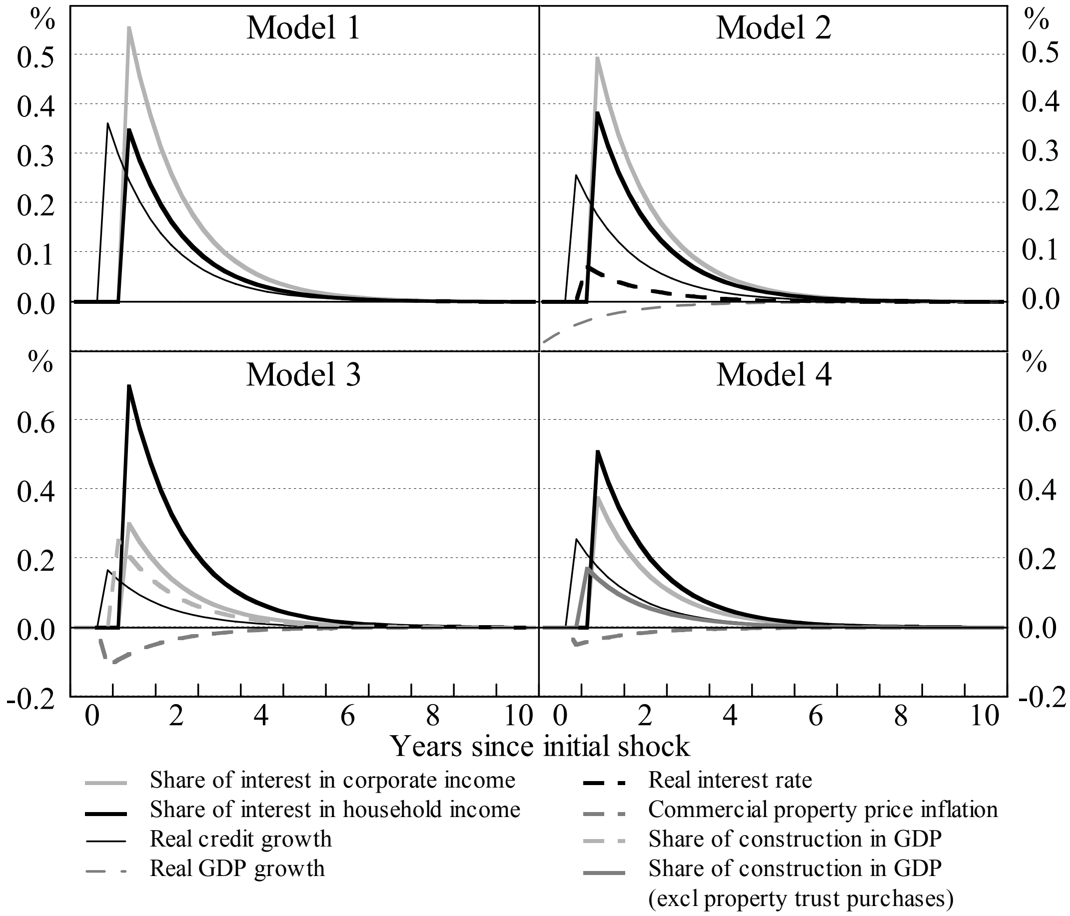
5 The sample excludes those banks that reported for less than six consecutive quarters.

6 The Breusch-Pagan test for heteroscedasticity accepts (at a one per cent significance level) the hypothesis that the variance of each model's residuals is equal across banks. Since most of the independent variables vary through time, but are constant across banks, the estimated models may be prone to heteroscedasticity where the residual variance differs across time periods. The Breusch-Pagan test also accepted the hypothesis that the variance of each model's residuals did not exhibit such clustering.

Figure 4: Impulse Response Functions

Response of impaired assets to a one-standard deviation shock (for one quarter) in each variable



The first model presented in Table 3 highlights the relationship between the corporate and household sectors' interest burden and banks' credit risk. There is a well-determined positive relation between banks' impaired assets and both the corporate and household interest burden. Each percentage point increase in the share of interest in household disposable income is predicted to yield a 0.20 percentage point increase in impaired assets, while the same increase in the share of interest payments in corporate income would increase impaired assets by just 0.07 percentage points. Over the past decade, corporate gearing has been more than four times more variable than household gearing. As a result, a one-standard deviation rise in corporate gearing is estimated to increase the impaired assets ratio by 0.55 percentage points, while a one-standard deviation rise in household gearing would raise the impaired assets ratio by 0.35 percentage points.

Thus, while banks' impaired assets are more sensitive to movements in household gearing, the probability of household gearing having as large an impact on banks' impaired assets as corporate gearing is small. Nevertheless, the findings that banks' impaired assets are more sensitive to household gearing than corporate gearing is surprising. Although the share of housing and personal loans in total bank lending increased over the decade (from 33 per cent to 41 per cent) it remains the case that most bank lending is provided to businesses. Moreover, home loans (which averaged around 80 per cent of non-business lending) have been particularly low risk; since 1994, home loans in arrears by 90 days or more have averaged just 0.4 per cent of banks' total home loans. The strong relationship between banks' impaired assets ratio and household gearing may reflect the broader macroeconomic impacts of changes in household gearing due to its effect on household expenditure or may simply reflect limitations of the data.

Impaired assets are also found to be strongly and positively related to the rate of real credit growth. This is consistent with rapid loan growth leading to increased lending to more marginal borrowers, which could be due to either reduced credit standards resulting from a shift in the supply of debt finance or the demand-side effects outlined by Calomiris *et al* (1997). This relationship takes effect with a quite short lag (just three quarters). This would seem to conflict with the analysis of Rajan (1994) and Calomiris *et al* which suggests that in the short run a negative relation is to be expected and only over the longer run would rapid credit growth generate increases in the impaired assets ratio. Our result is strongly influenced by the large movements in credit growth in 1990 and impaired assets during the early years of the 1990s that saw the realisation of credit quality problems, which had built up over the previous decade.

The second model adds real GDP growth and real interest rates to the first model. Acceleration in GDP growth is associated with a contemporaneous fall in the impaired assets ratio, although the estimated relationship is not particularly well determined. This result is consistent with the short-term relationship suggested by Calomiris *et al* and with the results of the cross-country studies discussed in Laker (1999).

The real interest rate has a reasonably strong effect on the impaired assets ratio over and above its effect on the corporate and household sectors' interest burden. Each percentage point increase in real interest rates is estimated to increase the impaired assets ratio by 0.05 percentage points. This is consistent with the effect of real interest rates on firms' risk-taking posited by Diamond (1991).

The third model brings together the economy's interest burden, real credit growth and influences coming from the property and construction sector. Commercial property prices and the share of construction in GDP both exert a strong influence over banks' credit risk. Consistent with the importance of commercial property as collateral against secured loans, a one-percentage point slowdown in commercial property price inflation is estimated to increase the impaired assets ratio by 0.06 percentage points.[7]

The share of construction in aggregate activity exerts a strong influence over the impaired assets ratio. Each percentage point increase in the share of construction in aggregate activity is estimated to lead to an increase in the impaired assets ratio of almost 0.4 percentage points. Moreover, construction activity dominates the variables included in model 2 that are not included in model 3 – real GDP growth and the real interest rate. As is the case for the relation between real credit growth and impaired assets, the effect of increases in construction flows through quickly. Again, this largely reflects the crystallisation of loan losses following from the run-up in construction activity in the late 1980s.

Of most relevance to banks is construction activity financed by bank loans. While banks are the main source of funds for construction, over the second half of 1990s the value of property assets held by public unit trusts grew rapidly (growing at an average rate of 23 per cent per annum between 1994 and 1999). Data on banks' lending for construction are only available for the second half of the 1990s. To take account of the growth in listed property trusts a fourth model is estimated which includes construction less gross purchases of property by listed property trusts as a share of GDP. This measure is subject to two main shortcomings. Firstly, it is not possible to distinguish between property trusts' purchases of newly completed

7 Following Kent and Lowe (1997), who find evidence that collateral effects work through nominal rather than real property price inflation, nominal property price inflation is included in this model.

construction and established buildings. As a result there is some mismatch between construction activity and property trusts' purchases. Secondly, the measure still includes construction activity financed from other non-bank sources.

It remains the case that impaired assets are strongly and positively related to the share of construction in activity after adjusting for property trust purchases. However, the sensitivity of impaired assets to construction is somewhat reduced, falling from 0.4 percentage points to 0.3 percentage points. Since construction including that financed outside the banking system has a larger impact on impaired assets than the narrower measure, this suggests that the broader macroeconomic effects of a build-up in construction activity have an important effect on banks' credit risk over and above the direct effect that comes from developments in the credit quality of the construction projects financed by banks.

The effect of movements in the exchange rate, the terms of trade and share prices on banks' impaired assets was also investigated. Unlike the results found in several cross-country studies, these variables exhibited no well-determined relationship with Australian banks' impaired assets. Australia did not, during the 1990s, experience exchange rate shocks anywhere near as large as countries such as Argentina, Chile, Mexico, Norway and Sweden. Nor did Australia experience severe falls in equity prices.

Comparing the four models it can be seen that most of the through-time variation in impaired assets is due to developments in corporate gearing and real credit growth. Although the addition of the property-sector variables reduces the size of the estimated effect of gearing and credit growth on impaired assets, overall these relations are reasonably robust to changes in model specification. While the share of construction in GDP and the real interest rate are also strongly correlated with the impaired assets ratio, the inclusion of these variables does not greatly improve the model's explanatory power.

4. The Profitability of Australian Banks 1960–1999

A weakness in the preceding analysis is that data are available for less than one full cycle in banks' credit quality. To analyse the effect of macroeconomic variation on banks over the longer term, profitability data, specifically, the after-tax return on assets earned by banks is considered.

Whilst banks' return on assets is influenced by their credit risk, the relationship between the two is not straightforward. Movements in the return on assets will reflect not just credit risk, but the full range of risks, including banks' exposures to movements in interest rates and exchange rates, liquidity risk and operational risks. Moreover, banks' return on assets reflects not just risk-taking, but also other factors such as the mix of on- and off-balance sheet business, operating efficiency, the level of competition within the banking market and regulatory constraints. The relationship between risk and return also depends upon whether banks price for risk, and the lags between taking on risk and the crystallisation of risk into realised losses. To the extent that banks earn higher returns by taking on riskier business, this will boost the return on assets. However, if a bank experiences losses beyond what it had provisioned for, such losses will reduce profitability. Over the 1990s, the return on assets and the impaired assets ratio exhibited strong negative contemporaneous correlation.

4.1 A Simple Comparison of Firm-specific and System-wide Variation

Figure 5 shows movements in the average level and distribution of asset returns since 1960.[8] It can be seen that the credit problems of the early 1990s resulted in the largest losses in forty years. Up until the mid 1970s, there was little movement in banks' asset returns and the distribution of returns was quite narrow. Smaller banks were, however, more profitable than the larger institutions (the unweighted mean being around 0.3 percentage points higher than the asset-weighed mean until 1975).

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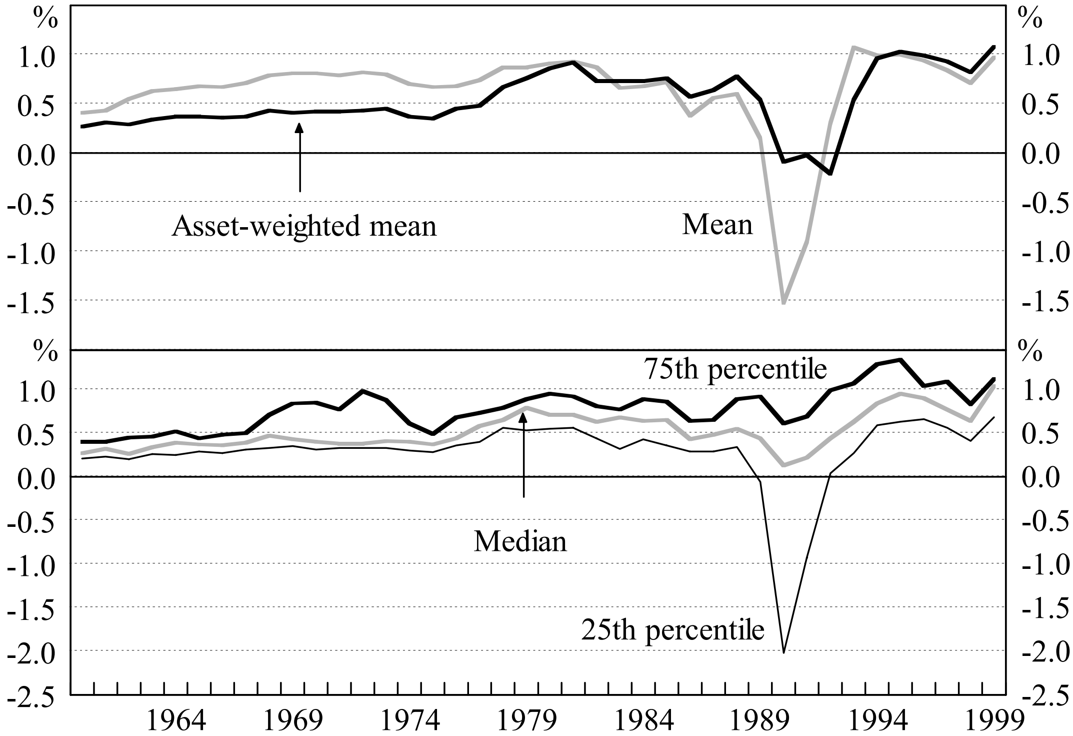
8 Profit figures are adjusted to exclude government assistance provided to the State Bank of Victoria in 1990 and State Bank of South Australia in 1991.

Figure 5: The Distribution of Banks' Operating Profit After Tax/Total Assets



From the second half of the 1970s, financial liberalisation allowed banks to increase their return on assets. The dispersion across banks also widened considerably. Between 1960 and 1975 the interquartile range averaged 0.3 percentage points; since then it has averaged 0.6 percentage points.[9] The difference in returns across banks, however, became less influenced by bank size. On average since 1980 there has been little difference between the unweighted and asset-weighted means.

Decomposing the panel variance using analysis of variance techniques outlined in Section 3.1 indicates that while interbank variation in profitability exceeds through-time variation, most of the variation lies in the residual (Table 4). In contrast to the impaired assets data discussed above, when the asset-share weights are applied the share of interbank variation in total panel variation increases substantially. Although several of the smaller banks made losses in 1990, which caused the fall in the unweighted mean, in terms of the overall variability of the panel, this is outweighed by the large losses made by large banks in 1990, 1991

9 Excluding the four years 1989–1992, the interquartile range has averaged 0.5 percentage points since 1976.

and 1992.[10] The share of variability through time also falls when the asset weights are applied, indicating that the smaller banks' profitability tends to be more variable than the larger banks'.

Table 4: Decomposition of Variance
Share of total variance, per cent
Panel sample: 1960–1999

	Banks	Time	Residual
Unweighted	22.9	13.4	63.7
Asset-weighted	66.7	8.7	24.6

4.2 Banks' Return on Assets and the Macroeconomy

Demirgüc-Kunt and Huizinga (1999), in their cross-country comparison of bank profitability, find that higher real interest rates and, to a lesser extent, higher growth in real per capita GDP are associated with stronger bank profitability. While their finding of a positive relationship between per capita output and bank profitability is consistent with other studies that focus on banking risk, the positive relation between profitability and real interest rates runs counter to the findings of the risk-based studies. The results can be rationalised, however, by the fact that in periods of high interest rates banks are often able to earn higher interest rate spreads as well as running higher risks (Reserve Bank of Australia 1999).

Figures 6 and 7 present the weighted-average return on assets and macroeconomic indicators of financial system stability. The longer run of data highlights the increase in the share of interest payments in corporate income during the 1980s, which was a product of a substantial increase in the corporate sector's gearing, and (in the second half of the 1980s) high real interest rates.[11]

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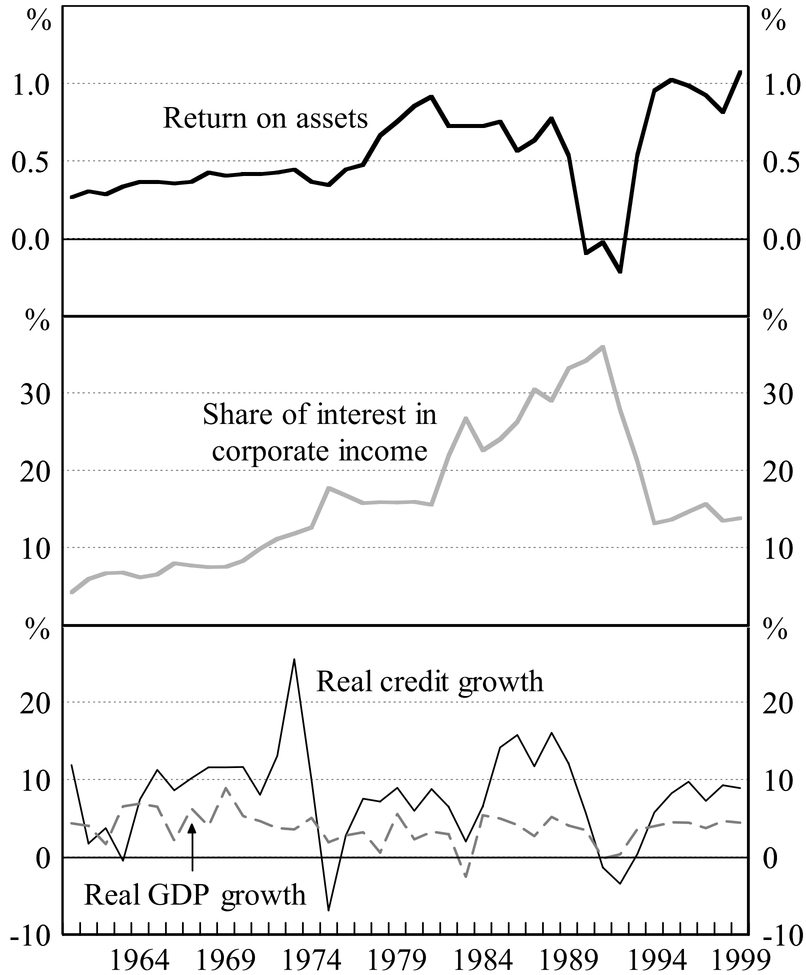
[10] When the State Bank of Victoria failed in 1990, and when the State Bank of South Australia failed in 1992, each was the 5th largest in the industry at the time. In 1992, Westpac, then the largest bank, and ANZ, ranked third, both reported large losses.

[11] Since a robust measure of commercial property price inflation over the 1960s is not available, residential property price inflation is considered in its place (during the 1990s the two price measures broadly moved together). In addition, data on the share of interest payments in the household sector's income are not available prior to 1973 so the household sector is not included in the analysis that follows.

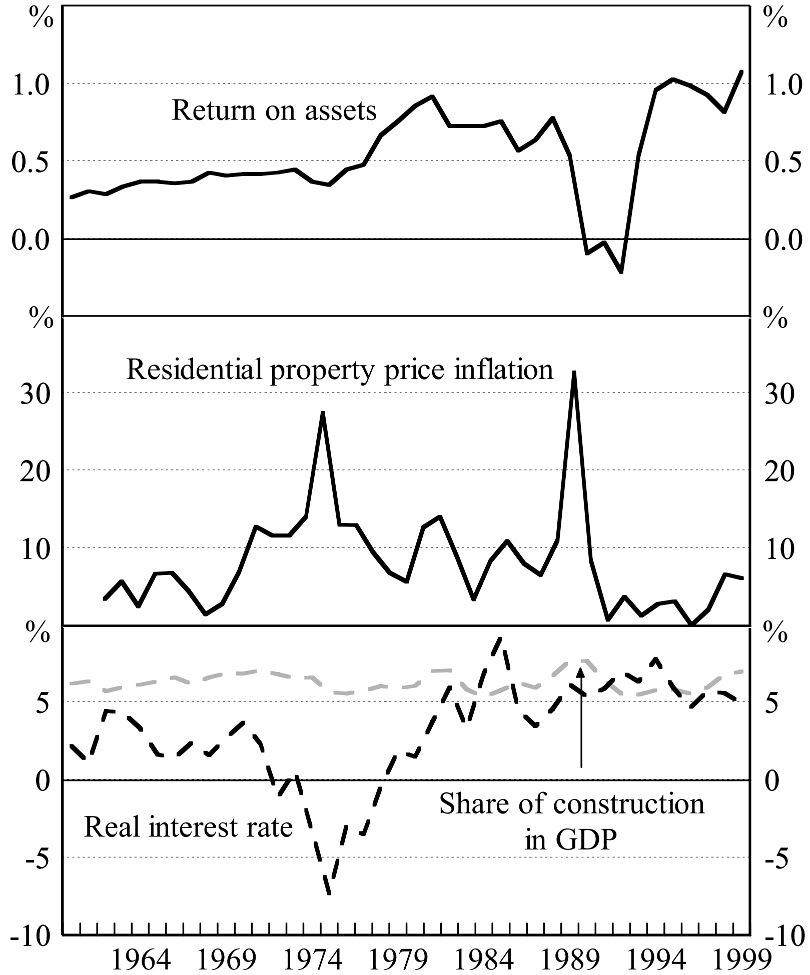
Figure 6: Banks' Return on Assets and the Macroeconomy



The slowdown in real GDP growth in 1990 coincided with the banks' losses in that year. The recession of 1983, however, was accompanied by only a slight reduction in banks' profits. Similarly, while the share of construction in GDP reached historically high levels in 1989–1990, peaks around the same level in 1971 and 1982 occurred in periods when bank profits were stable or rising.

The dramatic peaks in residential property price inflation in 1974 and 1989 preceded periods of contraction in real credit. It was only the later episode, however, that had any marked impact on bank profitability. The muted response in 1974 reflects the impact of the close regulation of banks during the 1970s.

Figure 7: Banks' Return on Assets and the Macroeconomy



To more closely quantify the effect of macroeconomic variation on banking profitability, the panel regression analysis presented in Section 3.3 is repeated taking the return on assets as the dependent variable (Table 5).[12]

[12] As in the analysis of impaired assets presented in Table 3, the choice of fixed effects is supported by the apparent absence of heteroscedasticity across banks. The Breusch-Pagan test accepts (at the one per cent significance level) the hypothesis that the variance of each model's residuals does not differ across banks. Unlike the previous models, however, the Breusch-Pagan test accepts the hypothesis that the variance of each model's residuals differs across time periods. The return-on-assets models, therefore, are estimated using estimated generalised least squares to adjust for this form of heteroscedasticity (Judge *et al* 1988).

Table 5: Return on Assets and the Macroeconomy

Dependent variable: operating profit after tax/total assets

Panel sample (annual data): 1960–1999

Independent variable	**Coefficient**	**Independent variable**	**Coefficient**	**Independent variable**	**Coefficient**
Model 1		Model 2		Model 3	
Trend_t	0.00012*** (0.00005)	Trend_t	0.00015*** (0.00005)	Trend_t	0.00021*** 0.00006
Return on assets_{t-1}	0.113*** (0.041)	Return on assets_{t-1}	0.109*** (0.041)	Return on assets_{t-1}	0.093*** (0.040)
Share of interest in corporate income_{t-1}	–0.014** (0.007)	Share of interest in corporate income_{t-1}	–0.014** (0.007)	Share of interest in corporate income_{t-1}	–0.029*** (0.008)
Real credit growth_{t-1}	–0.025*** (0.007)	Real credit growth_{t-1}	–0.020*** (0.008)	Real credit growth_{t-1}	–0.012** (0.007)
		Real interest rate_{t-1}	–0.015* (0.010)	Residential property price inflation_{t-3}	0.017*** (0.007)
				Residential property price inflation_{t-4}	0.011*** (0.005)
Adjusted R-squared	0.2326	Adjusted R-squared	0.2259	Adjusted R-squared	0.2337
Akaike's information criteria	–1089.1	Akaike's information criteria	–1083.4	Akaike's information criteria	–1088.1

Notes: The models are estimated using estimated generalised least squares to adjust for heteroscedasticity in the form of variation in the residuals across time. The models include bank-specific fixed effects. Figures in parentheses show the standard error of the coefficient estimate. ***, **, * denote significance at the 1, 5 and 10 per cent levels respectively.

Like the impaired assets data, the annual profitability data provide an unbalanced panel. Of the 21 banks included in the panel regression, only 6 were in operation throughout the whole period. The banks included in the panel (and the years for which annual reports were available) are listed in Appendix A.

Again, a trend term is included. In each model the trend effect is small but significantly positive. Here the trend is taken to proxy the impact of deregulation. A trend term, rather than a distinct structural break, is included as the process of deregulation was a gradual one. Restrictions on bank interest rates and lending policies were progressively eased between 1973 and 1986, allowing banks to expand into new, more profitable, areas of business, and allowing banks greater control over their interest margins (Battellino and McMillan 1989).

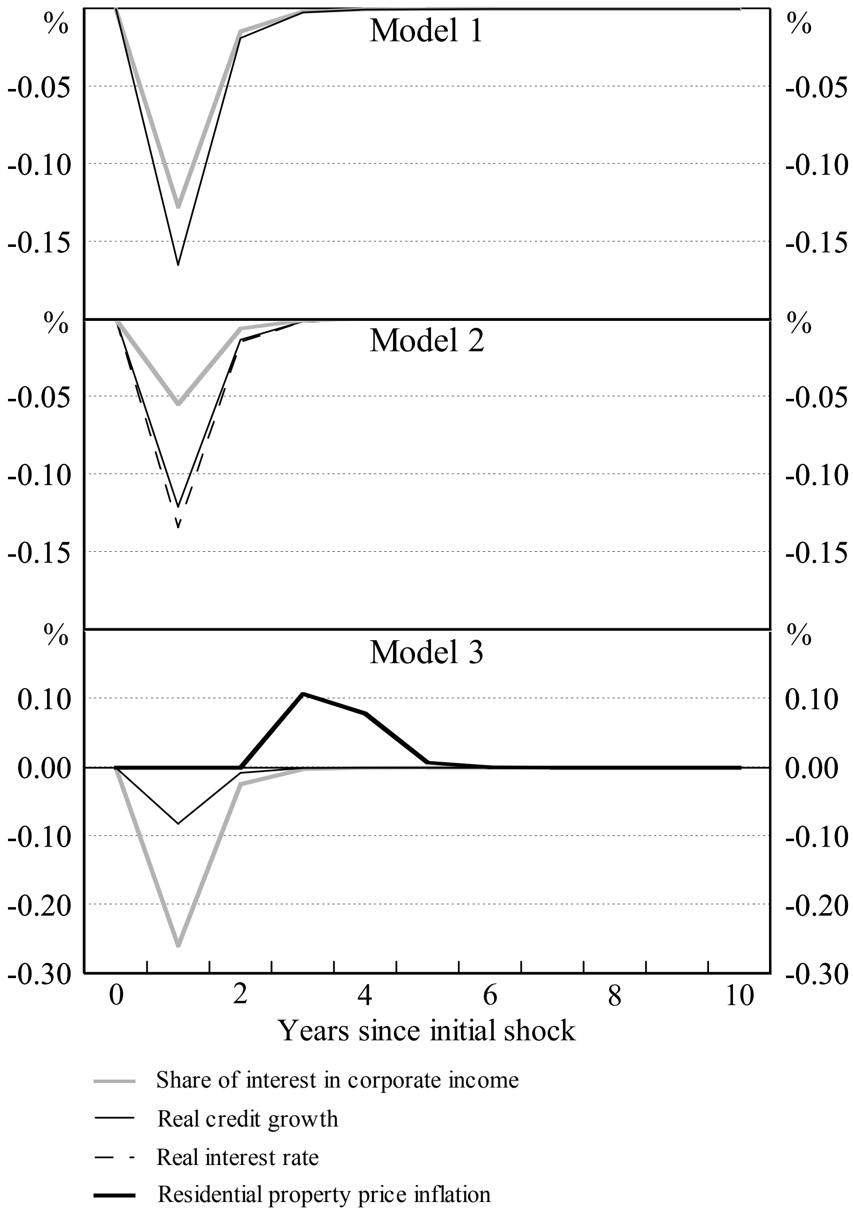
Consistent with the negative correlation between impaired assets and profits during the 1990s, the coefficients on all variables have the opposite sign to that found in the models of impaired assets. This would suggest that banks have not fully priced for risk by increasing margins as risk increases. Rather than increased risk resulting in higher bank profits, higher risk has reduced bank profitability.

Consistent with the results from the first model of impaired assets shown in Section 3.2, the share of interest in corporate income and real credit growth display a strong relationship with bank profitability. Each percentage point increase in the share of interest in corporate income is estimated to reduce the return on assets by around 0.01 percentage points.

Similarly, the return on assets is predicted to fall by 0.03 percentage points for each percentage-point acceleration in real credit growth. Accelerated real credit growth is found to reduce bank profits with a lag of one year. Rajan (1994) and Calomiris *et al* (1997) predict that such a response should reflect a long-run, rather than short-run, effect of rapid credit growth on banks' risk. That the observed response is relatively quick largely reflects the rapid acceleration in credit growth during the late 1980s preceding the loan loss problems of 1990–1992. The impulse response functions shown in Figure 8 demonstrate that the strong relation between real credit growth and bank profits combined with the high variability of real credit growth (particularly during the mid 1970s) has seen real credit growth have a large effect on banks' return on assets.

Figure 8: Impulse Response Functions

Response of the return on assets to a one-standard deviation shock (for one year) in each variable



The second model shows that real interest rates exert some influence beyond their effects on corporate gearing. In line with Diamond's prediction that higher real interest rates increase the likelihood of borrower defaults, increases in real interest rates reduce bank profitability: each percentage point increase in real interest rates lowers profitability by around 0.02 percentage points (this relationship, however, is not strongly significant). The negative relation found between bank profits and real interest rates runs counter to Demirgüc-Kunt and Huizinga's findings, suggesting that in Australia's case the effect of high real interest rates in impairing banks' credit quality has outweighed banks' capacity to earn higher margins. In contrast to the results presented in Section 3.2, real GDP growth did not exert a significant influence on banks' profitability beyond its effect on the share of interest in corporate income.

The third model shown in Table 5 combines gearing and credit growth measures with property price inflation. The importance of property as collateral underlying secured bank lending is borne out by the positive relation between residential property price inflation and bank profitability: a one percentage point increase in property price inflation is found to lead to an increase in banks' return on assets of 0.03 percentage points. This effect, however, is seen to take several years. Although the share of construction in GDP was found to have a strong effect on impaired assets during the 1990s, over the longer period it did not have a significant influence over the return on assets.

While all three models leave most of the variation in the return on assets unexplained, extending the first model does not greatly improve explanatory power. In addition, extending the first model does not greatly change the estimated coefficients on corporate gearing and credit growth.

5. Conclusion

The relative importance of system-wide and firm-specific factors influences the stability of the overall financial system and the way in which shocks are transmitted through the financial system and the broader economy. The relative weight of these two sources of variation also bears on policy prescriptions aimed at strengthening financial system stability. While micro-level risks are reduced by individual-institution prudential supervision (including controls such as capital adequacy requirements and limits on lending concentrations), system-wide risk is minimised by maintaining sound macroeconomic policy.

The size of, and variation in, individual-institution differences highlights the contribution that individual-institution prudential supervision can make to financial system stability. It is neither possible, nor desirable, to require that all institutions conform to the same risk profile. However, to the extent that supervision reins in risk-taking by those institutions lying at the high-risk extreme of the spectrum, this is likely to strengthen the financial system as a whole. The effect of economic variables on banks' performance also suggests that prudential policies that strengthen incentives for banks to act in a counter-cyclical way (for example, by encouraging banks to increase their capital ratios as economy-wide gearing rises) can effectively reduce the risk of system-wide instability.

The strength of the relation between the macroeconomic variables considered and banks' risk indicates that macroeconomic policy has an important role to play in providing a stable environment for banks to operate in. The extent to which monetary policy, in particular, should be set with an eye towards financial system stability, rather than focusing solely on price stability, remains controversial. Nevertheless, our results suggest that sound monetary policy is an important pre-condition for financial system stability.

The simple models presented in this paper provide a first pass at assessing how macroeconomic conditions may affect financial system risk. The relatively small datasets available (both in terms of the number of banks and the length of time) constrain the scope of empirical analysis. Our simplistic analysis, which assumes that each bank responds to macroeconomic developments in the same way, fails to address the interaction between macroeconomic and individual-firm effects, and therefore is likely to understate the effect of the macroeconomy on banks' credit risk and profitability. Since both the level and dispersion of impaired assets and banking profitability move with the economic cycle, some portion of the observed interbank variation may also be due to macroeconomic effects. The inclusion of bank-specific variables (such as bank size, loan concentration, asset composition and the speed of lending growth) into the modelling framework would allow a more complete investigation of the relative contribution of individual-bank characteristics and movement in macroeconomic variables on overall bank risk and performance.

Appendix A: Data

Banking Data

Quarterly panel

Bank	Sample period
Adelaide Bank	March 1994–September 1999
Advance Bank Australia	June 1990–December 1996
Arab Bank Australia	September 1994–September 1999
Australia and New Zealand Banking Group	June 1990–September 1999
Bankers Trust Australia	June 1990–September 1999
Bank of America Australia	June 1990–September 1995
Bank of China	June 1990–September 1999
Bank of Melbourne	June 1990–September 1997
Bank of New Zealand	June 1990–December 1992
Bank of Queensland	September 1990–September 1999
Bank of Singapore (Australia)	June 1990–June 1996
Bank of South Australia	June 1990–June 1995
Bank of Tokyo – Mitsubishi (Australia)	June 1990–September 1999
Bank of Western Australia (BankWest)	June 1990–September 1999
Banque Nationale de Paris	June 1990–December 1996
Barclays Bank PLC	March 1994–December 1996
Bendigo Bank	September 1995–September 1999
Challenge	June 1990–September 1995
Citibank	June 1990–September 1999
Colonial State Bank	June 1990–September 1999
Commonwealth Bank of Australia	June 1990–September 1999
Deutsche Bank AG	June 1990–December 1996
HSBC Bank Australia	June 1990–September 1999
IBJ Australia Bank	June 1990–September 1999
ING Bank (Australia)	December 1994–September 1999
Lloyds Bank NZA Ltd	June 1990–December 1996
Macquarie Bank	June 1990–September 1999
Mitsubishi Bank of Australia	June 1990–March 1996
National Australia Bank	June 1990–September 1999
NatWest Markets Australia	June 1990–December 1997

Bank (*continued*)	Sample period
Standard Chartered Bank Australia	June 1990–September 1999
St. George Bank	September 1992–September 1999
Suncorp-Metway	June 1990–September 1999
Trust Bank	June 1990–September 1999
Westpac Banking Corporation	June 1990–September 1999

Source: Data reported to the Reserve Bank (up until July 1998) and APRA (thereafter).

Annual panel

Bank	Sample period	
Advance Bank Australia	1986–1996	Acquired by St. George Bank
Australia and New Zealand Banking Group[(a)]	1960–1999	
Australian Bank	1982–1988	Acquired by State Bank of Victoria
Australian Resources Development Bank[(a)]	1968–1989	Acquired by National Australia Bank
Bankers Trust Australia[(a)]	1987–1998	Acquired by Deutsche Bank
Bank of America Australia[(a)]	1960–1977	Acquired by ANZ
Bank of America Australia	1986–1994	
Bank of Melbourne	1990–1997	Acquired by Westpac
Bank of Queensland[(a)]	1960–1999	Prior to 1970 operated as Brisbane Permanent Building and Banking Company
Bank of Singapore (Australia)	1987–1995	
Bank of Tokyo – Mitsubishi (Australia)	1986–1998	Prior to 1995 operated as the Bank of Tokyo
Bank of Western Australia[(a)]	1960–1999	Prior to 1994 operated as the Rural and Industries Bank of Western Australia
Challenge	1987–1994	Acquired by Westpac
Citibank[(a)]	1986–1998	
Colonial State Bank[(a)]	1960–1998	Prior to 1996 operated as the State Bank of New South Wales
Commercial Bank of Australia[(a)]	1960–1981	Merged with Bank of New South Wales
Commercial Banking Company of Sydney[(a)]	1960–1981	Merged with National Australia Bank
Commonwealth Bank of Australia[(a)]	1960–1999	
HSBC Bank Australia[(a)]	1987–1998	
IBJ Australia Bank [(a)]	1987–1998	

Bank (*continued*)	Sample period	
Launceston Bank for Savings[(a)]	1960–1986	Merged with Tasmania Building Society to form Tasmania Bank
Lloyds Bank NZA	1986–1995	
Macquarie Bank[(a)]	1986–1999	
Mitsubishi Bank of Australia	1986–1995	Merged with Bank of Tokyo
National Australia Bank[(a)]	1960–1999	
National Mutual Royal Bank	1986–1989	
NatWest Markets Australia	1986–1996	
Primary Industry Bank of Australia	1979–1987	Acquired by Rural and Industries Bank of Western Australia
The Savings Bank of Tasmania[(a)]	1960–1990	Merged with Tasmania Bank to form Trust Bank
St. George Bank	1993–1998	
Standard Chartered Bank Australia[(a)]	1987–1998	
State Bank of South Australia[(a)]	1960–1992	
State Bank of Victoria[(a)]	1960–1990	Acquired by Commonwealth Bank
Suncorp-Metway	1989–1999	
Trust Bank	1991–1998	Acquired by Colonial State Bank
Westpac Banking Corporation[(a)]	1960–1999	Prior to 1982 operated as the Bank of New South Wales

(a) Included in panel regression.
Source: Annual reports

Macroeconomic Data

Quarterly data

Share of interest in corporate income: Net interest payments of private, non-financial corporations as a share of private, non-financial corporations' gross operating surplus.

Source: *Australian National Accounts: National Income*, *Expenditure and Product*, ABS Cat No 5206.0.

Share of interest in household income: Household disposable income, interest payments – consumer and housing.

Sources: ABS Cat No 5206.0; ABS unpublished data.

Real credit growth: Seasonally adjusted credit deflated by the gross domestic product implicit price deflator – 1997/98=100, quarterly growth rate.

Sources: Reserve Bank of Australia *Bulletin* Table D.2; ABS Cat No 5206.0.

Real GDP growth: Gross domestic product – expenditure, average 1997/98 prices, seasonally adjusted, chain-linked, quarterly growth rate.

Source: ABS Cat No 5206.0.

Real interest rate: 90-day bank bill rate deflated using the private consumption deflator over the previous four quarters.

Sources: Reserve Bank of Australia *Bulletin* Table F.1; ABS Cat No 5206.0.

Commercial property price inflation: Quarterly growth in the implied price index derived from changes in the value of property assets held by property trusts.

Source: ABS Cat No 5645.0.

Share of construction in GDP: Private gross fixed capital expenditure (seasonally adjusted) as share of gross domestic product – expenditure (seasonally adjusted).

Source: ABS Cat No 5206.0.

Share of construction (excluding property trust purchases) in GDP: Private gross fixed capital expenditure (seasonally adjusted) less gross purchases of property by listed and unlisted unit trusts as share of gross domestic product – expenditure (seasonally adjusted).

Sources: ABS Cat No 5206.0; ABS Cat No 5645.0.

Annual data

Share of interest in corporate income: Net interest payments of private, non-financial corporations over the financial year as a share of private, non-financial corporations' gross operating surplus.

Source: ABS Cat No 5206.0.

Real credit growth: Seasonally adjusted credit deflated by the gross domestic product implicit price deflator – 1997/98=100, financial year year-on-year growth.

Sources: Reserve Bank of Australia *Bulletin* Table D.2; Foster (1996); ABS Cat No 5206.0.

Residential property price inflation: Growth in annual (financial year) average price index.

Sources: March 1960–December 1969, Treasury; March 1970–December 1981, Abelson (1983); March 1982–June 1986, Real Estate Institute of Australia; September 1986–December 1999, ABS.

Real GDP growth: Gross domestic product – expenditure, average 1997/98 prices, seasonally adjusted, chain-linked, financial year year-on-year growth.

Source: ABS Cat No 5206.0.

Real interest rate: 10-year treasury bonds, end June, deflated using the consumer price index over the previous year.

Sources: Reserve Bank of Australia *Bulletin* Table F.2; Foster (1996).

Share of construction in GDP: Private gross fixed capital expenditure over the financial year (seasonally adjusted) as share of gross domestic product – expenditure (seasonally adjusted).

Source: ABS Cat No 5206.0.

References

Abelson P (1983), 'The Determination and Prediction of House Prices', Macquarie University School of Economic and Financial Studies Research Paper No 262.

Allen R (1997), 'Alternative Approaches to the Diversification of Portfolios', in B Gray and C Cassidy (eds), *Credit Risk in Banking,* Proceedings of a Conference, Reserve Bank of Australia, Sydney, pp 166–188.

Basel Committee on Banking Supervision (2000), *Industry Views on Credit Risk Mitigation*, Basel, January, available at <http://www.bis.org/publ/index.htm>.

Battellino R and N McMillan (1989), 'Changes in the Behaviour of Banks and Their Implications for Financial Aggregates', Reserve Bank of Australia Research Discussion Paper No 8904.

Calomiris W and J Karceski (1998), *Is the Bank Merger Wave of the 1990's Efficient?*, AEI Press, Washington.

Calomiris C, A Orphanides and S Sharpe (1997), 'Leverage as a State Variable for Employment, Inventory Accumulation and Fixed Investment', in F Capie and G Woods (eds), *Asset Prices and the Real Economy*, Macmillan Press, London, pp 169–193.

Cole R and J Gunther (1995), 'Separating the Likelihood and Timing of Bank Failure', *Journal of Banking and Finance*, 19, pp 1073–1089.

Croxton F, D Cowden and S Klein (1967), *Applied General Statistics*, 3rd edn, Sir Isaac Pitman and Sons Ltd, London.

Demirgüc-Kunt A (1989), 'Deposit-institution Failures: A Review of Empirical Literature', Federal Reserve Bank of Cleveland Economic Review, 25(4), pp 2–18.

Demirgüc-Kunt A and H Huizinga (1999), 'Determinants of Commercial Bank Interest Margins and Profitability: Some International Evidence', *The World Bank Economic Review*, 13(2), pp 379–408.

Diamond D (1991), 'Monitoring and Reputation: The Choice Between Bank Loans and Directly Placed Debt', *Journal of Political Economy*, 44(4), pp 689–721.

Drake L and D Llewellyn (1997), 'Credit Crunch: A British Perspective', in F Capie and G Wood (eds), *Asset Prices and the Real Economy*, Macmillan Press, London, pp 106–160.

Eisenbeis R, G Ferrier and S Kwan (1999), 'The Informativeness of Stochastic Frontier and Programming Frontier Efficiency Scores: Cost Efficiency and Other Measures of Bank Holding Company Performance', Federal Reserve Bank of Atlanta Working Paper Series No 99/23.

Emmons W (1993), 'Increased Risk-taking versus Local Economic Conditions as Causes of Bank Failures', in *FDICIA: An Appraisal. Renaissance, Requiem or Just Another Acronym*, Proceedings of the 29th Annual Conference on Bank Structure and Competition, Federal Reserve Bank of Chicago, Chicago, pp 189–209.

Foster R (1996), Australian Economic Statistics 1949/50 to 1994/95, Reserve Bank of Australia Occasional Paper No 8.

González-Hermosillo B, C Pazarbaşioğlu and R Billings (1997), 'Determinants of Banking System Fragility: A Case Study of Mexico', IMF Staff Papers 44(3), pp 295–314.

Judge G, W Griffiths, R Hill, T Lee and H Lütkepohl (1988), *Introduction to the Theory and Practice of Econometrics*, 2nd edn, John Wiley and Sons, New York.

Kaufman G (1998), 'Central Banks, Asset Bubbles and Financial Stability', Federal Reserve Bank of Chicago Working Papers Series WP98/12.

Keeton W (1999), 'Does Faster Loan Growth Lead to Higher Loan Losses?', *Federal Reserve Bank of Kansas City Economic Review*, 84(2), pp 57–75.

Kent C and P Lowe (1997), 'Asset-price Bubbles and Monetary Policy', Reserve Bank of Australia, Research Discussion Paper No 9709.

Kiyotaki N and J Moore (1997), 'Credit Cycles', *Journal of Political Economy*, 105(2), pp 211–248.

Laker J (1999), 'Monitoring Financial System Stability', Reserve Bank of Australia *Bulletin*, October, pp 1–13.

Lowe P and T Rohling (1993), 'Agency Costs, Balance Sheets and the Business Cycle', Reserve Bank of Australia Research Discussion Paper No 9311.

Macfarlane I (1991), 'The Lessons for Monetary Policy', in I Macfarlane (ed), *The Deregulation of Financial Intermediaries,* Proceedings of a Conference, Reserve Bank of Australia, Sydney, pp 175–199.

Minsky M (1995), 'Financial Factors in the Economics of Capitalism', in H Benink (ed), *Coping with Financial Fragility and Systemic Risk*, Kluwer Academic Publishers, Boston, pp 3–14.

Murphy K, A Shleifer and R Vishny (1989), 'Industrialization and the Big Push', *Journal of Political Economy*, 97(5), pp 1003–1026.

Rajan R (1994), 'Why Bank Credit Policies Fluctuate: A Theory and Some Evidence', *Quarterly Journal of Economics*, 109(2), pp 399–441.

Reserve Bank of Australia (1995), *Prudential Statement No L1 Asset Quality*, January.

Reserve Bank of Australia (1999), 'Recent Developments in Interest Rates on Bank Lending', Reserve Bank of Australia *Bulletin*, April, pp 1–7.