CAPITAL MANAGEMENT OF DEPOSIT TAKERS: THE IMPACT OF PRUDENTIAL REQUIREMENTS

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ABSTRACT

This paper explores how the proximity of an institution’s capital-adequacy ratio to the regulatory minimum influences the capital-adequacy ratio observed in the following period. It is shown that banks and credit unions react differently to the prudential constraints. The majority of banks tend to operate with a small buffer of capital above the regulatory minimum; if their capital-adequacy ratio gets too close to the minimum then the bank tends to increase the ratio over the next year, while if the bank finds itself with a ratio well above the minimum then it is inclined to decrease the ratio. In contrast, the capital-adequacy ratio for many credit unions evolves like a random walk.

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# Table of Contents

1 INTRODUCTION

2 THE METHODOLOGY
   2.1 THE STANDARD APPROACH
   2.2 AN ALTERNATIVE APPROACH
   2.3 INTERPRETING TRANSITION PROBABILITY KERNELS

3 PRUDENTIAL CAPITAL REQUIREMENTS IN AUSTRALIA
   3.1 PRUDENTIAL CAPITAL CONSTRAINTS ON BANKS
   3.2 PRUDENTIAL CAPITAL CONSTRAINTS ON CREDIT UNIONS

4 LAWS OF MOTION FOR CAPITAL
   4.1 BANKS
   4.2 CREDIT UNIONS

5 THE ADJUSTMENT MARGINS

6 CONCLUSION

A A CLOSER LOOK AT TRANSITION PROBABILITY KERNELS

B ONE-QUARTER-AHEAD LAWS OF MOTION
   B.1 BANK
   B.2 CREDIT UNIONS
1 INTRODUCTION

As capital requirements have taken on a greater and more sophisticated role in the armoury of prudential supervisors, it has become increasingly important to understand how these constraints influence the activities of the financial institutions that they affect. In particular, it is vital for prudential supervisors to know how binding their capital constraints are. If capital requirements do not affect the capital management of the supervised institutions, then work directed towards making the constraints more sensitive to the risk profiles of the institutions is redundant, from a prudential perspective. This issue is particularly relevant in view of the current push toward reforming the existing capital requirements.

The reforms to prudential capital requirements are largely being driven by the view that capital requirements are expensive for financial institutions to meet, given the relatively high cost of equity funds compared to debt funds. These arguments, based on a perceived relationship between the cost of funds and leverage, derive from either distortions induced by the taxation system (Modigliani & Miller 1963) or distortions in principal-agent relationships (Jensen & Meckling (1976) and Myers & Majluf (1984)). This argument suggests that, faced with a relatively high cost of new equity funds, institutions should reduce their capital-adequacy ratios to the regulatory minimum, plus a small buffer to ensure that the constraints will not be violated.¹

If Authorised Deposit-taking Institutions (ADIs) are bound by prudential requirements then it is important to make the constraints sensitive to their risk profiles. If this is not done, then pressures to minimise the use of relatively expensive capital will encourage ADIs to engage in regulatory arbitrage and could potentially lead to an overall increase in the riskiness of institutions. These incentives to increase risk are particularly strong in countries that have explicit or implicit deposit guarantees, since they insulate the owners of ADIs from some of the downside associated with increased risk. The likelihood of this occurring has been widely discussed in the United States since the introduction, in 1981, of regulatory capital requirements that were independent of risk (see, for example, Koehn & Santomero (1980) and Kim & Santomero (1988)). Alfriend (1988) also refers to this distortion when explaining the relatively large number of bank failures that occurred in the United States following the introduction of these capital requirements.

¹ Harris & Raviv (1991) provide an excellent survey of capital structure determinants.
At present, prudential capital requirements are not very sensitive to the risk profiles of the supervised institutions. However, the imperative for reform of these requirements, to alleviate the problems outlined above, is dependent on whether the existing capital constraints are binding. This paper constitutes an empirical exploration of how restrictive the capital requirements are on banks and credit unions in Australia. In particular, this paper documents how the distribution of capital-adequacy ratios, for these institutions, has evolved since the introduction of their respective capital requirements. It also estimates “laws of motion” for capital-adequacy ratios, which illustrate how the proximity of an institution’s capital-adequacy ratio to the regulatory minimum influences behaviour in the next year. Finally, it explores how institutions go about changing their capital-adequacy ratios if they do become subject to regulatory pressure, by relating capital adjustments to the growth of total assets.

The results of this paper can be summarised as follows. First, many institutions attempt to operate with a small capital buffer in excess of the regulatory minimum. Second, a fraction of institutions hold capital well in excess of the regulatory minimum. For these institutions, the tendency to reduce capital to a level closer to the minimum is weak. This conflicts with the notion that equity funds are significantly more expensive than alternative funding sources. Together, these findings suggest that the prudential constraints are not binding for all institutions and that the regulatory arbitrage case for reform of the existing arrangements may be overstated.

Similar issues have been explored empirically for financial institutions in the United States and the United Kingdom. Shrieves & Dahl (1992) and Jacques & Nigro (1997) examine the impact of prudential capital requirements on US banks. While Shrieves & Dahl (1992) find that the imposition of capital constraints was associated with an increase in bank capital, Jacques & Nigro (1997) extend this result to show that the increases in capital for individual institutions were insensitive to the extent to which they were bound by the capital constraints. This extension suggests that the increases in capital may have been driven by a third factor influencing all banks, rather than by prudential requirements; the prudential requirements should only have influenced banks with capital at or below the regulatory minimum.

Ediz, Michael & Perraudin (1998) find that banks in the United Kingdom tend to raise their capital-adequacy ratios in response to pressure from the prudential supervisor. This is interpreted as evidence that prudential constraints do influence the capital management of UK banking institutions. Ediz et al. (1998) also find that the increases in capital induced by regulatory pressure tend to manifest as changes in Tier 1 capital rather than changes in either Tier 2 capital or the portfolio of assets against which capital is required to be held.
The remainder of this paper is as follows. Section 2 explains the approach used to characterise the capital management of financial institutions. Section 3 discusses the prudential capital requirements applying to banks and credit unions during the sample period. Next, Section 4 presents the laws of motion. Section 5 relates the aggregate adjustment in capital-adequacy ratios to the change in the total assets of institutions. Finally, Section 6 teases out implications of the observed approaches to capital management for the future development of prudential policy.

2 THE METHODOLOGY

2.1 The Standard Approach

The methodology employed by Ediz et al. (1998) is representative of the approach adopted by many researchers. They use a partial-adjustment model in which the institution's capital-adequacy ratio, $K$, adjusts according to:

$$\Delta K_{it} = \gamma (K_{it}^* - K_{it-1}) + \epsilon_{it}$$

where $K_{it}^*$ is the optimal capital-adequacy ratio, $\gamma$ is a positive parameter, $\epsilon$ is a random error term, $i$ indexes institutions and $t$ indexes time. In the long run $K$ converges to the optimal $K^*$, and $\gamma$ reflects the speed with which this adjustment occurs. Since an institution's desired level of capital cannot be observed, $K^*$ is always proxied by a range of variables intended to capture the factors affecting optimal capital structure. In the case of Ediz et al. (1998), these include:

- the ratio of fee income to net income;
- the ratio of net interest income to risk-weighted assets;
- the ratio of deposits from banks to risk-weighted assets;
- the ratio of off-balance-sheet items to risk-weighted assets;
- the ratio of profit to risk-weighted assets;
- the ratio of total provisions to risk-weighted assets; and
- the ratio of total assets to risk-weighted assets.

2 See also, Peltzman (1970), Mingo (1975) or Dietrich & James (1983).
To this basic model, Ediz et al. (1998) add two dummy variables, one to capture any recent increase in the regulatory capital requirement and the other to indicate if the lagged capital-adequacy ratio is close to the regulatory minimum. The significance or otherwise of these dummy variables constitutes a test for whether regulatory requirements influence the capital management of UK banks.

The validity of this approach rests heavily on the ability of the wide range of financial-statement variables to capture the optimal capital-adequacy ratio. To the extent that additional factors, including the size of the institution, have not been controlled for, estimates of the parameters on the dummy variables are biased and inconsistent.3 A further problem with this model is that it is overly restrictive in terms of the relationship between prudential capital constraints and the capital management of institutions. By using dummy variables to capture the effects of policy, it becomes impossible to investigate related issues, such as the often talked about buffer of capital that institutions may try to maintain between their actual capital-adequacy ratio and the regulatory minimum. The model is also unable to incorporate any influence on capital from external rating agencies. The next subsection suggests a way of relaxing these methodological constraints.

2.2 An Alternative Approach

Instead, this paper uses non-parametric methods to characterise the evolution of capital-adequacy ratios for banks and credit unions. No attempt is made to proxy the optimal capital-adequacy ratios of individual institutions and, importantly, no functional form is imposed upon the interaction of actual capital-adequacy ratios and prudential capital requirements. The only assumption made is that the capital-adequacy ratio follows a first-order Markov process, implying that the capital-adequacy ratio in the next period is a stochastic function of the capital-adequacy ratio in the current period. The form of this function is able to adjust with the current level of capital, enabling very rich types of capital structure evolution to be captured.

These benefits do come at a cost. To estimate these laws of motion for capital-adequacy ratios, it is necessary to pool across institutions and through time. This means, for example, that the capital management of a large domestic banking institution with a capital-adequacy ratio of 10 per cent is restricted to be the same as that of a small regional bank that also has a capital-adequacy ratio of 10 per cent. Unfortunately, the small sample size limits the extent to which separate laws of motion can be estimated for different categories of institutions.

3 See Lowe & Shuetrim (1992) and Shuetrim, Lowe & Morling (1993) for evidence that there are a wide range of factors, omitted by Ediz et al. (1998), that significantly influence capital management.
To motivate the technique used in this paper, we return to the partial adjustment model shown in Equation 1. If the target capital-adequacy ratio in the current period is equal to the capital-adequacy ratio in the preceding period (implying that $K_{it}^* = K_{it-1}$), the partial-adjustment model reduces to a random walk:

$$\Delta K_{it} = \epsilon_{it} \tag{2}$$

In this case, it becomes unnecessary to control for the individual characteristics of institutions. Formally, $K_{it-1}^*$ is a sufficient statistic for determining the institution’s optimal capital-adequacy ratio. This formulation would apply to institutions that do not have strong preferences over their capital structure. Then, so long as capital management is costly, the actual capital-adequacy ratio can be represented as a random walk.4

Alternatively, if institutions have no capital adjustment costs (corresponding to $\gamma = 1$ in equation 1) and if their optimal capital-adequacy ratio is time invariant, then the partial adjustment model reduces to:

$$K_{it} = K_{it}^* + \epsilon_{it} \tag{3}$$

With $K_{it}^*$ being time invariant, there is again no need to control for it explicitly when estimating the law of motion for capital-adequacy ratios.

The methodology in this paper, by assuming that there is no need to condition on $K_{it}^*$, takes these special cases as the null hypothesis. Rather than developing a model that explains changes in the capital-adequacy ratio in terms of a range of institutional characteristics, this paper estimates the law of motion for the capital-adequacy ratio under the assumption that the behaviour of capital adequacy in the next period is governed by current capital adequacy. More formally, this law of motion is a characterisation of the probability distribution from which the next period’s capital-adequacy ratio is drawn, conditioning on the current capital-adequacy ratio. The entire law of motion is then just the full set of conditional densities, one for each possible value of the current capital adequacy ratio. This law of motion, more commonly known as a transition probability kernel, describes the stochastic process governing the evolution of capital ratios. To the extent that the conditional distributions are symmetrically distributed around the current capital ratio and are unimodal, they describe a random walk process for capital.

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4Clearly, the random walk is bounded below by the requirement that institutions remain solvent.
If the null hypothesis proves to be incorrect, then the laws of motion, estimated in this paper, remain valid descriptions of capital behaviour conditioned only on a subset of the relevant information. That is, they could be improved by the addition of extra conditioning information, other than the current capital-adequacy ratio. However, as Section 4 shows, the random-walk hypothesis is a reasonable characterisation of capital management for institutions with capital well in excess of prudential requirements.

Construction of these laws of motion involves two steps. First, the bivariate density of \((K_{it}, K_{it+1})\) is estimated, where \(j\) is the number of quarters taken for a single transition from one value of the capital-adequacy ratio to another. This estimation can be done in a number of ways, perhaps the most common being the construction of a relative-frequency histogram. Because of the sparsity of data, however, a relative-frequency histogram will imply an unlikely number of discrete jumps in the distribution function. To resolve this, and other problems associated with relative frequency histograms, this paper uses a kernel-density estimator which smooths the relative frequency histogram by using a normal-density function to spread out the probability mass associated with each observation.\(^5\) This non-parametric technique results in estimates of probability-density functions with the nice properties that they are continuous and differentiable and they integrate to unity.

The second step toward estimating the laws of motion involves conditioning this bivariate density function on the current capital-adequacy ratio. This requires the marginal density of \(K_{it}\) to be obtained by integrating out \(K_{it+j}\) from the joint density. Next, the densities of \(K_{it+j}\), conditional on a particular value of \(K_{it}\), can be computed by dividing the joint density, \((K_{it}, K_{it+j})\), by the value of the marginal density at the chosen value of \(K_{it}\). Obtaining this conditional density of the next period's capital-adequacy ratio, for each possible value of the current capital-adequacy ratio, yields the desired law of motion.

One complexity arising in the estimation of the law of motion stems from the possibility that an institution will merge with another institution, be taken over or enter bankruptcy. In all cases, the cessation of activities marks the end of capital-adequacy ratio observations for that particular institution. This means that, given the current capital-adequacy ratio, an institution can either have a capital-adequacy ratio in the next period or it can exit the sample. The possibility that an institution will cease to be observed adds an extra discrete element to the distribution of possible outcomes for the institution's capital-adequacy ratio in the next period. Because this extra element is discrete, the method described above for estimating the laws of motion needs to be adapted because kernel-density-estimation techniques are only useful for distributions with continuous support.

\(^5\) See Silverman (1986) for a more complete and formal explanation. Also, more detailed information on the application of kernel-density estimation to transition probability kernels is contained in Appendix A.
The potential for institutions to exit from the sample means that the bivariate densities must be constructed from two components. First, the joint density is estimated, in the usual way, using all of the observations for which institutions continue to operate. Second, the univariate density of current capital-adequacy ratios is estimated for all firms that exit in the next period. The probability mass in each of these densities is then scaled by the number of observations used in their construction relative to the total number of observations available to ensure that the full joint density, taking into account the possibility of exit, integrates to unity. After obtaining the full joint density, the conditioning process can be applied as described above. The entire law of motion for capital-adequacy ratios can then be presented in the form of two graphs: one pertaining to those institutions that continue operations in the next period and the other applicable to those that exit in the next period.

2.3 Interpreting Transition Probability Kernels

The following two examples illustrate, using synthetic data, how transition probability kernels will be presented in this paper. For simplicity, it is assumed that no institutions leave the sample. The first example illustrates a transition probability kernel for a random walk. The dataset underlying Figure 1 consists of 5,000 observations generated by a random walk with an initial value of 10 and whose shocks are normally distributed with mean zero and variance one.

The transition probability kernel is depicted using a contour plot, the darker regions portraying outcomes that have a higher probability of occurrence. The vertical axis represents values of the variable in the current period while the horizontal axis represents possible outcomes of the variable in the ensuing period. Thus, taking a horizontal cross-section through the contour diagram yields the density function of the variable in the next period, conditioned on its value in the current period.

As is clear from Figure 1, the transition probability kernel for a random walk has the probability mass concentrated along the 45-degree line running from the bottom-left corner of the contour plot to the top-right corner. A similar configuration for the laws of motion of capital-adequacy ratios would, therefore, constitute evidence that the behaviour of capital-adequacy ratios resembles that of a random walk.
The second example illustrates a transition probability kernel for white-noise data, generated by taking 5,000 draws of a variable with a mean of 10 and a variance of one.

The contour plot for the white noise process contrasts strikingly with that for the random walk. Instead of having the probability mass concentrated around the 45-degree line, it is grouped along a vertical line at the variable's mean. Since the conditional density of the variable is independent of the variable's current value, the conditional densities should all be identical. This is exactly the message of a vertical alignment of probability mass in the transition probability kernel. In the context of capital-adequacy ratios, this type of behaviour could be expected to arise for institutions bound by prudential capital requirements.

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6 Any observed variations are only due to sampling error.
In practice, transition probability kernels may demonstrate random-walk characteristics over some parts of their domain and white-noise characteristics over other parts of their domain. Indeed, considerably more complex behaviour may be represented by transition probability kernels as illustrated, for example, in the study of equity beta convergence by Shuetrim (1998). It is in this sense that the methodology of this paper imposes no functional form upon the law of motion for capital-adequacy ratios.

The next section describes the prudential capital requirements that banks and credit unions had to comply with during the period under study. It also employs univariate kernel-density estimation techniques to illustrate how the distribution of capital-adequacy ratios has evolved for these two classes of institutions. This evidence must be used in conjunction with the laws of motion, shown in Section 4, to form a complete picture of how the institutions under study are managing their capital.

3 PRUDENTIAL CAPITAL REQUIREMENTS IN AUSTRALIA

Before empirically examining the capital management of financial institutions in Australia, it is important to explain the prudential restrictions in effect during the sample period. For banks, the sample period extends from June 1989 to December 1998 while, for credit unions, it runs from June 1992 to December 1998. During the bulk of this period, the regulatory framework was organised around institution type, with separate agencies regulating the activities of each class of institution: the Reserve Bank of Australia supervised banks while State Supervisory Authorities (SSAs), under the administration of the Australian Financial Institutions Commission (AFIC), had responsibility for credit unions. Following an extensive inquiry into Australia’s financial system, the Australian Prudential Regulation Authority (APRA) was established to take over the regulatory responsibilities of a number of agencies, including the Reserve Bank and the SSAs. Although APRA was formed on 1 July 1998, the transition of responsibilities away from the SSAs did not occur until 1 July 1999.

That said, the prudential capital requirements imposed by the Reserve Bank and the SSAs were similar in nature since they were both derived from the Basle Accord on Capital Adequacy. There were, however, a few differences that are worth noting. The following subsections describe these differences and relate the introduction of the prudential capital requirements to the evolution of capital-adequacy ratios for banks and credit unions. Where relevant, the subsections also highlight differences in the capital requirements imposed in Australia and those imposed in the United Kingdom and the United States, where similar studies have been conducted.
3.1 Prudential Capital Constraints on Banks

The prudential requirements on banks are specified in a set of prudential statements. Although these prudential statements are non-statutory, banking licences are granted on the condition that the body corporate to which the licence is granted conforms to the arrangements for prudential supervision. If dissatisfied, the Reserve Bank had the legislative power to revoke a banking licence.\(^7\)

The prudential statements are closely aligned to the standards developed by the Basel Committee on Banking Supervision. This is consistent with prudential supervision in all other industrialised nations, including the United Kingdom and the United States. The statement of most relevance for this paper is “Prudential Statement C1 - Capital Adequacy of Banks”.\(^8\) This statement has the following pertinent features:

- Capital is defined as Tier 1 (equity capital and disclosed reserves\(^9\)) plus Tier 2 capital (undisclosed reserves, asset revaluation reserves, general provisions, hybrid capital instruments, and subordinated debt);

- Credit exposures (on- and off-balance sheet) are weighted according to five broad categories of relative risk, based largely on the nature of the counterparty; and,

- Capital adequacy is measured using a “capital-adequacy ratio”. This is calculated by dividing a bank’s capital base by its total risk-weighted assets. Each bank is expected to maintain, on both a consolidated group and stand-alone basis, a ratio of at least 8 per cent (of which Tier 1 capital will be at least 4 per cent; furthermore, Tier 2 capital cannot exceed Tier 1 capital for capital-adequacy purposes).\(^10\)

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\(^7\) Banking Act 1959 (Commonwealth) para. 9A(2)(a)(iii).

\(^8\) Prudential Statement C1 replaced “Prudential Statement No. 16 - Capital Adequacy of Banks”, in March 1996. The substance of this statement has changed little since the inception of Prudential Statement No. 16 in August 1988.

\(^9\) Examples of disclosed reserves are the non-repayable share premium account, general reserves, and retained earnings.

\(^10\) The Reserve Bank was able to require a bank to maintain a ratio higher than the prescribed minimum. This may be done, for example, for a newly established bank, or a bank judged to have excessive risk exposures. Prior to the introduction of Prudential Statement C1 and its predecessors, Australian banks were required to meet a capital-to-total-assets ratio.
Foreign bank branches are not subject to Prudential Statement C1. Although the parent will be expected to follow equivalent capital adequacy standards set by its home domicile supervisors, the branch itself will not be required to meet the standards. For this reason, foreign bank branches are excluded from this study.

Figure 3 shows the evolution, through time, of the distribution of capital-adequacy ratios across banks. The middle line shows the median capital-adequacy ratio in each quarter. The top and bottom lines show, respectively, the 75th and 25th percentiles of the capital-adequacy ratio distribution. Beginning in the June quarter of 1989, there was a significant increase in the capital-adequacy ratios. This adjustment was experienced by all institutions, regardless of their initial capital-adequacy ratio. This general trend continued until the March quarter of 1994; over this period, the median rose by 2.5 percentage points from 9.5 to 12 per cent. Over the ensuing couple of years, capital-adequacy ratios were fairly stable before beginning to contract towards the end of 1996. This decline was short lived, however, with capital-adequacy ratios rising shortly thereafter, increasing particularly strongly in the second half of 1998. Interestingly, the most-capitalised banks experienced the biggest increase.

**Figure 3: Evolution of Capital-Adequacy Ratios – Banks**

A final observation arising from Figure 3 is that the cross-sectional distribution of bank ratios is fairly tight, centred on approximately 11 per cent and with a mild positive skew. This observation is perhaps more evident in Figure 4, which shows the cross-sectional distribution pooled through time.

Figure 4 emphasises that while most banks operate with a small buffer of capital between themselves and the regulatory minimum, a substantial number of them operate with capital more than 50 per cent above that required by APRA.
There are a few reasons why banks operate with a buffer stock of capital. First, the level of economic capital may exceed the prudential requirements. Second, the opinion of rating agencies and market analysts has a large effect on the activities of banks. It is possible that these third parties impose more stringent capital requirements on banks than those imposed by APRA. Third, even if this is not the case, market discipline will, at the very least, mean that banks have strong incentives to ensure that they do not breach the prudential requirements; banks see it as very much in their commercial best interest to be seen to be complying with internationally recognised standards of supervision. This, coupled with variability in a bank’s capital-adequacy ratio, requires banks to maintain a sufficient buffer to ensure that they do not violate the constraints. It follows that the size of the buffer should vary between banks according to the volatility of their capital-adequacy ratio. Figure 5, which plots for each bank its mean capital-adequacy ratio against the mean absolute quarterly change in its capital-adequacy ratio, is supportive of this.

As mentioned above, the UK and the US also base their prudential requirements on the Basel Accord on Capital Adequacy. There are, however, some subtle differences. For example, the risk-weighting system in the UK places heavier weights on investments in government securities than do the Australian or US regimes. A more substantial difference is the practice adopted in the UK of setting bank-specific capital requirements, which are nearly always above the Basle minimum. In addition, UK supervisors also set “target” ratios for each bank; a breach of this target ratio triggers greater regulatory pressure, even though the prudential minimum has not been reached. In comparison, APRA adopts a less formal approach in that it only sets preferred ratios, above the regulatory minimum, if it has cause for concern.
3.2 Prudential Capital Constraints on Credit Unions

The Financial Institutions (FI) Scheme was established on 1 July 1992 to create a uniform approach to the regulation of state-based financial institutions. Although AFIC set the prudential standards and coordinated the supervision of FI-Scheme institutions, the day-to-day supervision rested with SSAs. On the whole, the capital-adequacy requirements applicable to these institutions – outlined in Prudential Standard 4.2 – are comparable to those discussed above. For example, each credit union must maintain a minimum ratio of capital to risk-weighted assets of in excess of 8 per cent. Furthermore, the definitions of capital, the required split between Tier 1 and Tier 2 capital, the asset risk-weighting framework and the credit conversion factors (used for converting off-balance sheet business into on-balance sheet equivalents) are all similar.

There are, however, a few differences worth mentioning. First, there is a tendency for the prudential standards to exceed those applying to banks. For example, FI-Scheme institutions may only enter into derivative contracts for the purpose of reducing market risk. This contrasts to the large trading books that banks are permitted to hold, where there are no such restrictions on derivative transactions. Second, SSAs were more prone to stipulate higher institution-specific minimum ratios if the overall riskiness of the institution was believed to have increased. Third, the prudential standards carry the force of law (under the AFIC Code) whereas, as mentioned above, the prudential statements that apply to banks are non-statutory.

The time-series movements in credit unions’ capital-adequacy ratios are shown in Figure 6.
After the FI Scheme was introduced in July 1992, the affected institutions were given two years to comply with the standards. During this transition period, there was a marked increase in the capital adequacy ratios of credit unions. This increase was observed across the board, with all three percentiles rising by comparable amounts. In early 1994, the upward trend slowed and soon thereafter the capital-adequacy ratios stabilised with the industry as a whole exhibiting greater stability than the banking sector. Not surprisingly, the entire distribution suggests that credit unions were more capitalised than banks; the 25th percentile for credit unions settled at approximately 11 per cent while, for banks, the same percentile fluctuated between 9 and 10 per cent. Further differences are that the dispersion of capital-adequacy ratios for credit unions is greater than that for banks and the positive skew is more accentuated. These observations are more evident in Figure 7, which shows the cross-sectional distribution pooled through time.

Figure 7 indicates that credit unions tend to maintain a more substantial buffer between themselves and the regulatory minimum; the mode of the distribution is around 13 per cent and a significant number of them operate with a capital-adequacy ratio more than 100 per cent above the regulatory minimum.

Figure 8 shows that the size of the buffer a credit union maintains is positively related to the volatility of its capital-adequacy ratio. Whilst credit unions are not subject to the same degree of market discipline, pressure from the supervisor provides credit unions with sufficient incentive to hold enough capital to ensure that the constraints are never violated.

The next section presents the laws of motion for banks and credit unions. These laws of motion characterise the stochastic processes that underly the evolution of capital-adequacy ratios discussed above. The evidence contained therein, in conjunction with that presented in this section, can be used to make inferences about the responsiveness of banks and credit unions to the existing prudential capital requirements.
Figure 7: Distribution of Capital-Adequacy Ratios - Credit Unions

Figure 8: Volatility of Capital-Adequacy Ratios - Credit Unions
4 LAWS OF MOTION FOR CAPITAL

Rather than pooling the data across all Authorised Deposit-taking Institutions, we estimate the laws of motion separately for banks and credit unions. We make this distinction for three chief reasons. First, as outlined in Section 3, banks operated in a different regulatory environment to that of credit unions. Second, the managers of the two classes of institutions have different objective functions: banks are profit maximisers while credit unions are non-profit organisations. The conflicting objectives are likely to lead to a difference in their approach to capital management. Third, banks and credit unions differ in their ability to raise capital: most banks are publicly listed while the vast majority of credit unions are mutual or co-operative organisations. The sample of bank data consists of quarterly observations from 45 banks which operated for all, or part, of the period June 1989 to December 1998. For credit unions, the sample consists of quarterly data collected from 356 institutions which operated for all, or part, of the period June 1994 to December 1998.

4.1 Banks

The one-quarter-ahead law of motion for banks is presented in Appendix 2. Since banks find it difficult to exert significant influence over their capital-adequacy ratio in such a short period of time, the results are likely to be biased in favour of finding that movements in the ratio resemble that of a random walk. For this reason, we prefer to focus our attention on the one-year-ahead law of motion.

The one-year-ahead law of motion, for banks that continue to operate, is shown in Figure 9. The contour plot is interpreted in the manner described in Section 2. For example, consider a bank with a current capital-adequacy ratio of 12 per cent. Reading horizontally across from 12 on the vertical axis provides us with the probability density function from which the next-year’s capital-adequacy ratio is drawn. As before, the darker regions indicate outcomes that have a greater probability of occurrence. Thus, in this example, the expected value of the capital-adequacy ratio next year is also approximately 12 per cent.

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11 We also estimated the laws of motion for building societies; however, the small number of observations limited the usefulness of the results.

12 Of the 45 banks, 27 are Australian owned and 18 are foreign bank subsidiaries. As explained in Section 3, foreign bank branches are excluded from the analysis because they are not subject to comparable capital requirements.
According to Figure 9, the stochastic process underlying movements in the capital-adequacy ratio is dependent on its current level. For instance, if the capital-adequacy ratio of a bank is well above the regulatory minimum, there is a tendency for the bank to decrease its capital-adequacy ratio over the next year. However, if the current level of the capital-adequacy ratio falls below the regulatory minimum, the underlying stochastic process begins to resemble white noise with a mean of around 9 per cent, reflecting the effectiveness of prudential constraints. In the transition period between these two extremes, the expected value of the capital-adequacy ratio in the next quarter is slightly above that of the current level. This suggests that as banks approach the regulatory minimum there is a strong tendency for them to increase their capital-adequacy ratio, as found in Ediz et al. (1998).

Figure 10, which depicts the probability of a bank exiting within the next year, conditioned on the current capital-adequacy ratio, completes the description of the law of motion. Interestingly, it suggests that a bank with large capital reserves is more likely to exit from the sample. This evidence supports the hypothesis that banks with large reserves of capital are seen as attractive takeover targets for other banks. The small number of banks exiting the sample, however, means that not too much reliance should be placed on this result.\(^{13}\)

To enrich our understanding of the dynamics of capital, we can use the estimated laws of motion to calculate the ergodic density of the capital-adequacy ratio of banks. The ergodic density can be interpreted as the long-run cross-sectional density that would arise in equilibrium if the estimated laws of motion were the true laws of motion.

\(^{13}\) There were 18 exits during the sample period.
To generate the ergodic density, we need to introduce new banks into the sample and assume an initial capital-adequacy ratio for these banks. We need to do this because, according to the estimated laws of motion, a proportion of banks exit each period; without introducing new banks to offset those that leave the sample, the number of banks would dwindle to zero and the ergodic density would be uninformative in that it would simply indicate that all banks end up closing their doors. We assume that, for every bank that leaves the sample, a new one replaces it and that all new banks have an initial capital-adequacy ratio of 8 per cent. This was chosen to ensure that our results are not biased against finding that the capital constraints are binding; by underestimating the initial capital-adequacy ratio of new banks, we bias the ergodic mass towards the prudential minimum. The ergodic density is estimated by iterative application of the one-quarter-ahead law of motion, augmented by the capital-adequacy ratio density of new banks. The result of this procedure is shown in Figure 11.

The key inference to be drawn from Figure 11 is that banks do not appear to be unduly concerned about reducing their capital holdings to the minimum required by APRA. If the prudential requirements were binding then, a priori, we would expect the ergodic density to be hard up against the regulatory minimum. However, the density function is quite dispersed around a mode of 10 per cent and a mean of 13 per cent. Whilst the mean of the density can be rationalised by arguing that banks wish to maintain a buffer of capital above the regulatory minimum, it is more difficult to explain the spread of capital-adequacy ratios if the capital requirements are binding constraints for all or most institutions.
What, therefore, can we conclude from the estimated laws of motion? As shown in Section 3, a large number of banks operate with a capital-adequacy ratio well in excess of the regulatory minimum. These banks display a slight disposition to decrease their capital-adequacy ratio over the next year. However, the ergodic density suggests that this tendency is only weak, with many banks continuing to maintain a high capital-adequacy ratio well into the future. The behaviour of capital-adequacy ratios for those banks operating near the regulatory minimum is strikingly different; these banks are prone to increase their capital-adequacy ratio over the next year to ensure that they do not breach the regulatory minimum. How they go about doing this is the focus of Section 5.

4.2 Credit Unions

The arguments for focusing on the one-year-ahead law of motion, as opposed to the one-quarter-ahead, are even more compelling for credit unions. This is because the nature of credit unions makes it extremely difficult for them to adjust their capital-adequacy ratio in a short space of time. There are a number of reasons why this is the case. First, the ownership structure of credit unions inhibits their access to capital - as mentioned earlier, most credit unions are mutuals or co-operatives. Second, credit unions find it difficult to restructure their balance sheets so as to improve their reported capital-adequacy ratios. This is largely because of the size of most credit unions; their small size makes it costly for them to enter into securitisation arrangements and to raise subordinated debt. For completeness, the one-quarter-ahead law of motion is presented in Appendix 2; not surprisingly, the results suggest that the stochastic process driving capital-adequacy ratios is similar to that of a random walk.
The one-year-ahead law of motion, shown in Figures 12 and 13, should paint a more accurate picture of the responsiveness of credit unions to the regulatory requirements. Looking first at those credit unions that continue to operate, Figure 12 shows that for credit unions with a capital-adequacy ratio well in excess of the regulatory minimum, the behaviour of their capital-adequacy ratio is indistinguishable from that of a random walk. However, for credit unions with a capital-adequacy ratio below 12 per cent, there is a tendency to increase their ratio over the next year.

Figure 12: One-Year-Ahead Law of Motion - Surviving Credit Unions

Figure 13, which shows the one-year-ahead law of motion for credit unions that exit in the following year, suggests that credit unions are more likely to leave the sample if they have low capital-adequacy ratios. This is consistent with the observation that many credit unions, when experiencing financial difficulties, are encouraged by their relevant SSA to merge with another credit union. The ergodic density of the capital-adequacy ratio for credit unions is estimated in the same manner as described for banks. This density, shown in Figure 14, indicates that the capital management of many credit unions is not constrained by prudential capital requirements; the density is well dispersed around a mode of around 24 per cent (the mean is also over 20 per cent).
Figure 13: One-Year-Ahead Law of Motion - Exiting Credit Unions

Figure 14: Ergodic Density - Credit Unions
In summary, the conclusions to be drawn from the laws of motion for credit unions are similar to those reached for banks. Specifically, credit unions that currently have a capital-adequacy ratio near the regulatory minimum are likely to increase this ratio over the next year. Most credit unions, however, operate with a much higher capital-adequacy ratio; in these instances, movements in the capital-adequacy ratio resemble that of a random walk. This observation is further supported by the ergodic density, which shows that credit unions do not reduce their capital-adequacy ratio to a level near the regulatory minimum.

5 THE ADJUSTMENT MARGINS

In the previous section it was found that both banks and credit unions increase their capital-adequacy ratios when they are bound by prudential capital requirements. This section goes one step further and investigates the methods by which these financial institutions manipulate their capital-adequacy ratios. An institution can increase its capital-adequacy ratio either by increasing the level of regulatory capital, the numerator of the ratio or, by decreasing total risk-weighted assets, the denominator. In turn, risk-weighted assets can be reduced by shrinking the size of the portfolio of assets or by shifting into assets that bear a lower risk weight.

It is, therefore, possible to break down observed changes in the capital-adequacy ratio into four components: Tier 1 capital (e.g., retained earnings and permanent shareholders' equity); Tier 2 capital (e.g., subordinated debt); portfolio size (e.g., number of loans); and the riskiness of the portfolio (e.g., shifting from corporate loans to residential mortgages).

The question that this section answers is, which of these methods do financial institutions use? This question can be answered by looking at the relationship between the capital-adequacy ratio in the current period and the margin on which changes to the capital-adequacy ratio occur over the next period. The most interesting result for banks stems from Figure 15, which shows the expected percentage change in total assets over the next year, conditioned on the capital-adequacy ratio in the current period.

Figure 15 suggests that banks with higher capital-adequacy ratios have, at most, a mildly greater tendency to grow their balance sheets. This belies claims that banks do not rapidly eliminate excess capital through share buybacks and increased dividend payments because they do not want to limit their ability to realise growth opportunities.14

14 It should also be noted that the freedom to conduct share buybacks has only been a recent phenomenon.
Not surprisingly, banks that are hard up against the prudential capital constraints appear unlikely to respond with aggressive business expansion.

The relationship between capital-adequacy ratios and both the rate of accumulation of capital and the riskiness of the portfolio were also examined. The results are not reported, however, as they reveal no significant relationship. The same analysis was also applied to credit unions. For credit unions, it appears as though most of the adjustment takes place in Tier 1 capital; changes in Tier 2 capital, portfolio size and the risk of the portfolio all appear to be independent of the capital-adequacy ratio.

6 CONCLUSION

This paper has explored the capital management of both banks and credit unions by estimating the laws of motion for the capital-adequacy ratios of these institutions. The primary advantage of this approach, over the methodology normally used in studies of this nature, is that it is not necessary to estimate optimal capital-adequacy ratios for each of the institutions in the sample. This is particularly important in Australia, given the lack of data on the characteristics of each individual institution.

Three results stand out from this work. First, prudential constraints on capital are effective in the sense that those institutions that have either breached or are close to the regulatory minimum increase their capital-adequacy ratio over the following quarters. If they are unable to do so, they exit from the industry.
Second, banks and credit unions tend to maintain a buffer stock of capital in excess of the regulatory minimum. This is evidenced by the equilibrium capital-adequacy ratio distributions for banks and credit unions: the long-run modal capital-adequacy ratio for banks lies between 10 and 11 per cent while the long-run modal capital-adequacy ratio for credit unions is over 20 per cent. The maintenance of buffer stocks appears to be driven by the institutions' need to never breach prudential constraints. Arguments that banks hold this buffer in response to the demands of third-party rating agencies are not verified by the contour plots in Section 4. If rating agencies imposed their own, more stringent capital requirements, then the contour plots would display kinks at those capital-adequacy ratios. This evidence is not conclusive, however, because the methodology used in this paper, by pooling across institutions, may not be precise enough to detect influences of a third party.

Third, a large number of institutions hold capital well in excess of the regulatory minimum. For these institutions, the tendency to reduce capital is relatively weak in the context of arguments for reform of prudential capital constraints. Given the supposed cost of holding capital, it is surprising that we have not seen more share buybacks or, for mutual structures, more changes in pricing structures to reduce capital. Arguments that excess capital must be conserved to ensure that future growth is not constrained by capital requirements are belied by the results in Section 5, which indicate no strong relationship between growth in assets and the amount of excess capital. These results suggest that the pressures to reduce capital are perhaps not as strong as is often claimed in the context of demands for reform of the existing capital requirements.

These findings, approximate though they are, carry substantial implications for the process of reforming prudential capital requirements. As indicated by McDonough (1988), the rising pressures for reform of the Basel Accord on Capital Adequacy are largely being driven by the view that financial institutions are increasingly able to benefit by engaging in “prudential arbitrages”, which increase the risk of losses to institutions while not increasing prudential capital requirements by a commensurate amount.

Economic capital, being driven by a need to hold the probability of institutional failure to a given level, is monotonically increasing in the level of risk (and return) that the institution is exposed to. Prudential capital, as discussed in Section 3, is based on much rougher approximations of financial institutions' risk exposures. These approximations mean that the relationship between prudential capital requirements and institutional risk are not monotonically increasing for all levels of risk. As a result, institutions are able to increase their risk exposures without necessarily increasing their prudential capital requirements.
However, the imperative for prudential capital reform arises only if the prudential capital constraints force financial institutions to hold capital in excess of economic capital. If the prudential requirements are not binding then making the requirements more sensitive to risk will not influence the amount of capital banks hold. In this situation, any decision to engage in "regulatory arbitrage" is, in truth, a strategic business decision - it is not being driven by prudential distortions.

The findings of this paper suggest that the prudential requirements may not significantly distort the investment decisions and risk profiles of many institutions; to the extent that institutions do not drive their capital-adequacy ratios down to a level near the prudential minimum, the level of economic capital must exceed the prudential requirements. Given these results, further work needs to be done to obtain more precise estimates of the relationship between the weighted average cost of capital for authorised deposit-taking institutions and their leverage.
APPENDIX A  A CLOSER LOOK AT TRANSITION PROBABILITY KERNELS

To estimate the bivariate density function of \((K_{it}, K_{it+j})\), we used non-parametric kernel-density estimation. Intuitively, the density estimate is a smoothed histogram wherein each observation in the histogram is replaced by the kernel function. The kernel function is simply a continuous, differentiable function that integrates to unity. In this paper, the standard normal distribution function is used as the kernel function. The individual kernel functions, one for each observation, are integrated to obtain the estimate of the population density function from which the sample has been drawn. By replacing each observation with the kernel function, this density estimate is continuous, smooth and it integrates to unity.

Formally, the kernel density estimate at \(x\) of random variable \(X\) is given by:

\[
\hat{f}(x) = \frac{1}{nh} \sum_{i=1}^{n} \mathcal{X}\left(\frac{x - X_i}{h}\right)
\]

where, \(X_i\) is the \(i\)’th realisation in the sample, \(h\) is the window width, \(n\) is the number of observations in the sample and \(\mathcal{X}(\cdot)\) is the kernel function.

The smoothness of the density estimate depends upon the choice of the smoothing parameter, \(h\). It defines the extent to which the probability mass associated with each observation is smoothed out over the support of the density. The larger the window width, the more smoothing that occurs in the estimation procedure because each observation is spread over a wider region of the support. In most cases, greater smoothing reduces the variance of the density estimate while increasing the bias.

When constructing the density estimates, a subjective approach to window width selection is adopted. The subjective approach is recommended by Silverman (1986) in situations where interest focuses on the shape of the density rather than on applying more formal non-parametric inference techniques. In the paper we have, as a general rule, assumed a window width of 1. Experimentation suggests that the information content of the density estimates is unaffected over a wide range of window widths. For example, Figures 16 and 17 show the one-year-ahead law of motion for banks, discussed in Section 4, when the assumed window width is set to 0.5.
Figure 16: One-Year-Ahead Law of Motion - Surviving Banks

Figure 17: One-Year-Ahead Law of Motion - Exiting Banks
APPENDIX B ONE-QUARTER-AHEAD LAWS OF MOTION

B.1 Banks

Together, Figures 18 and 19 describe the one-quarter-ahead law of motion for banks. For a large part of the domain, Figure 18 suggests that the stochastic process driving capital-adequacy ratios resembles that of a random walk. For those banks that cease to exist, the density function, shown in Figure 19, is similar to that for the one-year-ahead case.

Figure 18: One-Quarter-Ahead Law of Motion - Surviving Banks

Figure 19: One-Quarter-Ahead Law of Motion - Exiting Banks
B.2 Credit Unions

The one-quarter-ahead law of motion for credit unions is illustrated in Figures 20 and 21. Figure 20 shows that the behaviour of the capital-adequacy ratio is indistinguishable from a random walk regardless of the current level of capital. At no point do credit unions have a strong disposition to change their capital-adequacy ratio. Figure 21 is virtually identical to that for the one-year-ahead case.

Figure 20: One-Quarter-Ahead Law of Motion - Surviving Credit Unions

![Figure 20: One-Quarter-Ahead Law of Motion - Surviving Credit Unions](image)

Figure 21: One-Quarter-Ahead Law of Motion - Exiting Credit Unions

![Figure 21: One-Quarter-Ahead Law of Motion - Exiting Credit Unions](image)
REFERENCES


