An Investigation of the Impact of Interest Rates and Interest Rate Volatility on Australian Financial Sector Stock Return Distributions

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Abstract

This paper extends the existing literature by analysing the dual impact of changes in the interest rate and interest rate volatility on the distribution of Australian financial sector stock returns. In addition, a multivariate GARCH-M model is used to analyse the impact of deregulation on the financial institutions sector. It was found that there is a consistent inter-temporal trade off between risk and return over the different regulatory periods. Moreover, finance corporations were found to be highly sensitive to new shocks across the financial sector and deregulation increased the risk faced by finance corporations and small banks - effectively increasing the required rate of return and explaining the continued rationalisation of these sectors. Furthermore, deregulation has changed the fundamental relationship between interest rates and large bank stock excess returns from positive in the pre-deregulation period to negative in the post-deregulation period. This reflects the changing institutional environment from one of controlled credit rationing to a more competitive environment.

Keywords: Interest rate risk; Australian financial sector; Regulatory change; GARCH-M

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1. INTRODUCTION

The study of interest rates and their impact on banking stocks is an area of intense interest to practitioners, academics and regulators in both the public and private sectors. This issue also has implications for the implementation of monetary policy; risk management practices and valuation of a wide range of financial securities. However, despite the accumulated research effort in this area (see, for example, Saunders and Yourougou, 1990; Kwan, 1991; Neuberger, 1991; Choi *et al*. 1992; Dickens and Philippatos, 1994; Madura and Zarruk, 1995; Elyasiani and Mansur, 1998; and Faff and Howard, 1999) it remains a research question that is largely unsettled.

All stocks are potentially affected by interest rate changes but the degree of impact will vary widely. However, interest rate changes in banking and financial sector stocks directly feed into input costs, the operating margin and the demand for services by customers. Hence, theoretically, the level of interest rates and their volatility have a relatively higher and more consistent impact on financial sector stock return distributions. Further, the advent of financial market deregulation from a controlled credit-rationing regime to an open competitive environment, is a policy decision that potentially affects fundamental relationships between interest rates, pricing and risk in the financial sector. These issues motive our research.

The extant literature is predominantly confined to the US financial markets. In the Australian context the contemporary literature is limited to Faff and Howard (1999), wherein the authors investigated the impact of changes in interest rates upon the first moment of the distribution of bank stock returns using a two-index model. The current study extends this research by analysing the dual impact of changes in the interest rate and interest rate volatility on the first and second moments of the distribution of Australian financial sector stock returns. In addition, the impact of the deregulation of the banking system upon these effects is also investigated.

We utilise an enhanced version of the GARCH in mean (GARCH-M) model employed by Elyasiani and Mansur (1998) in their analysis of US bank stock returns. They found that (i) changes in interest rates has a direct impact on the first moment of the distribution of bank stock returns, and (ii) the associated volatility of interest rates has a direct impact on the second moment of the returns distribution. Further, the extent of this impact is affected by the size and nature of the institutions in question and is conditioned by regulatory change.

Two assumptions explicitly inform our research design. First, it is assumed that the process of banking deregulation can be divided into distinct periods. Second, it is assumed that that the impact of deregulation in each of these sub-periods will have distinguishable effects from interest rate risk. Both of these features of our research design permit us to investigate important variations around the central hypothesis – namely, (whether and) to what extent Australian financial institutions are exposed to interest rate risk. Specifically, these hypotheses engage the potential roles of (i) regulatory change; (ii) size of bank; and (iii) type of institution.

Our findings can be summarised as follows. Generally, we found that there is a consistent inter-temporal trade off between risk and return over the different regulatory periods. Moreover, finance corporations were found to be highly sensitive to interest rate shocks across the financial sector and deregulation increased the risk faced by finance corporations and small banks - effectively increasing the required rate of return and explaining the continued rationalisation of these sectors. Furthermore, deregulation has changed the fundamental relationship between interest rates and large bank stock excess returns from positive in the pre-deregulation period to negative in the post-deregulation period. This reflects the changing institutional environment from one of controlled credit rationing to a more competitive environment.

The remainder of the paper is partitioned into four sections: Section 2 provides the background, Section 3 describes the data and research methodology, the results are presented in Section 4, and conclusions are contained in Section 5.

2. BACKGROUND

(i) Does the Size and Nature of the Financial Institution Matter?

The majority view, (encompassed in Akella and Chen, 1990) suggests that large banks are more likely to hedge, which in turn, leads to a prediction that larger banks are less interest rate sensitive. Therefore we argue that the interaction between the underlying philosophies, opportunities, economies of scale and so on, support a 'generic' hypothesis (in alternative form) that interest rate sensitivity of small financial institutions and large institutions should differ.

On the question of the nature of the institution, there are two alternative approaches that can be taken. The first is an international comparison approach. That is, do we expect that Australian banks' interest rate exposure will be different to their international (say US, given that the bulk of existing evidence is from this dominant market) counterparts? Based on the arguments of commentators such as De Lucia and Peters (1993, p.238), who state that "…the Australian experience of interest rate risk management among the major banking institutions is a peculiar one." and then goes on to contrast them with those typical of US banks of similar size, the answer is in the affirmative. The second approach is a purely domestic comparison approach. That is, do we expect Australian banks' interest rate exposure will be different than, for example, Australian finance companies? Relevant to this question is the fact that finance companies do not accept retail deposits, and according to Hunt and Terry (1997) finance companies tend to maintain a similar maturity structure over their loans and fund sources. While this is suggestive of a tendency toward lower deposit driven interest rate exposure, the direction of the prediction may not be possible. Hence, similar to the previous discussion on size, with regard to the nature of financial institutions we state another ‘generic’ hypothesis (in alternative form); that interest rate sensitivity of banks and ‘non-banks’ should differ.

(ii) The Potential Impact of Deregulation

Up until the late 1970s the Australian banking sector was subject to an extensive, though reasonably stable, set of regulatory controls. As a consequence it was perceived that financial institutions were somewhat immune to credit, interest rate and exchange rate risks. During the 1980s much of this system of regulatory control was dismantled and the financial system was placed upon the path to deregulation.

As a consequence of these changes, Australian banks moved away from public sector securities to riskier loans and traded bills which, to a large extent, resulted in more volatile financial prices (Harper, 1991, p.83). Compounding this affect and increasing the interest rate sensitivity of financial institutions was the increased competition between different classes of financial institutions. For example, Grenville, (1991, p.28) draws attention to the growth of cash management trusts during the 1980s. These cash management funds attracted direct depositors away from banks, and forced banks to progressively rely on more expensive bill and bond markets for an increasingly greater proportion of their deposits. This resulted in banks' net interest margins being squeezed and heightening the effects of interest rate changes on their income stream. In analysing the process of deregulation, three distinct periods of adjustment can be distinguished.

The first period, the pre-deregulation period, began in January 1978 and ended in November 1983 with the floating of the Australian dollar. The choice of the floating of the Australian dollar as an appropriate event point to close the pre-deregulation period, recognises that it was the ‘signature’ event, that indicated to the global economy, Australia’s intent to move toward a largely de-regulated financial system (Grenville, 1991; Harper and Scheit, 1992; and Faff and Howard, 1999). For the second deregulation period, whilst it is reasonably clear that the initial period of deregulation effectively opens in December 1983, selecting an appropriate point at which to close this period is somewhat problematic. Faff and Howard (1999) followed Harper and Scheit (1992) and selected September 1987 in order to isolate the direct impact of the October 1987 stock market crash. However, this also depends on an appropriate opening post-regulatory period definition.

With the benefit of hindsight, it would seem prudent to identify the beginning of the post-regulatory period with a regulatory change that could credibly be argued as having a material impact on the interest rate risk of the Australian financial sector. Just such a regulatory change was made in January 1990 when the Reserve Bank of Australia (RBA) adopted a policy of announcing changes in its cash rate target to the market. In support of this choice, Lim and Martin (1994) found that this change significantly affected the rate of pass-through in the short-term money market. Further, Battellino, Broadbent and Lowe (1997) provided empirical evidence that this policy change dramatically reduced the volatility of overnight cash rates. Consequently, we have chosen to close the period of deregulation at December 1989, to open the post-deregulation period in January 1990, and to model the aforementioned impact of the October 1987 stock market crash using idiosyncratic dummy variables when necessary.

Moreover, the deregulation period of the Australian financial system signalled to financial institutions the advent of a new era when their exposure to risks of all types could be dramatically magnified, and so potentially necessitating significant changes in their risk management structures. In the context of the current paper our predictions regarding the interaction between interest rate risk exposure and regulatory change are captured by three 'generic' hypotheses. The first relates to our 'pre-deregulation' period in which we predict minimal interest rate sensitivity, primarily as a consequence of Reserve Bank of Australia supervision. Second, we have a 'deregulation' period in which the prediction is for increased interested rate sensitivity as financial institutions are faced with the perturbations bought about by the deregulated environment.

Finally, the 'post-deregulation' period we predict reduced interest rate sensitivity, primarily as a consequence of the adoption of improved risk management practices. Accordingly, we condition our model on an appropriate set of specified dummy variables and investigate whether this predicted cycle of increase interest rate sensitivity is uncovered.

3. DATA AND RESEARCH DESIGN

(i) Data

The data studied are discrete monthly returns that run from January 1978 to December 1998. The choice of the monthly sampling interval, over a long historical period is intended to capture long-term movements in volatility and to avoid the effects of settlement and clearing delays which are known to significantly affect returns over shorter sampling intervals.

From the Centre for Research in Finance (CRIF) database, prepared by the Australian Graduate School of Management, adjusted price data (which include dividends and adjustments for capitalisation changes) were obtained for 31 Australian banking and financial sector stocks. Utilising these 31 stocks, three portfolios were formed in which each constituent stock was given an equal weighting. The resulting indices are intended to serve as proxies for large banks, small banks and finance companies respectively, and are set out in Table 1.[1]

[TABLE 1 ABOUT HERE]

In addition to these three equally weighted indices, we use the value weighted Banking and Insurance Indices also obtained from the Centre for Research in Finance (CRIF) database as a proxy for the overall banking financial sector. Finally, the adjusted price data are transformed into holding period returns ($R_{j,t}$) as follows:

$$R_{j,t} = \frac{\left(P_{j,t} - P_{j,t-1}\right)}{P_{j,t-1}} \tag{1}$$

Turning now to the debt securities data, the Reserve Bank Bulletin provides monthly observations of the percent per annum yield (Y_t) on the 90-day bank-accepted bills. These percent per annum yields were converted into approximate holding period returns by calculating

$$R_t^{bb90} = \frac{\left(P^{bb90}{}_t - P^{bb90}{}_{t-1}\right)}{P^{bb90}{}_{t-1}} \tag{2}$$

where $P^{bb90}{}_{t-1} = 100 / [1 + Y_t(90/36500)]$ and $P^{bb90}{}_t = 100 / [1 + Y_t(60/36500)]$; the assumed buying and selling prices respectively. This return series (R_t^{bb90}), which serves as a proxy for the risk free rate of return, is then subtracted from the holding period return series of each indices to obtain an excess holding period return series for each index.

$$ER_{j,t} = R_{j,t} - R_t^{bb90} \tag{3}$$

Finally, the Commonwealth Bank Bond Accumulation Index for 10-year Commonwealth Government bonds was obtained from Datastream and transformed into a long run holding period return (LR), similar to equations (1) and (2). This return series is utilised as a proxy for the holding period return on long-term debt securities.

As previously discussed, in addition to these stochastic time series variables two dummy variables D_2 and D_3 are constructed to allow the model to be conditioned on three periods of regulatory change involved in the deregulation of the Australian banking industry.[2]

$$D_2 = \begin{cases} 1 & \textit{December } 1983 \leq \textit{TIME} \leq \textit{December } 1989. \\ 0 & \textit{otherwise} \end{cases}$$

$$D_3 = \begin{cases} 1 & \text{T}\textit{ime} \geq \textit{January } 1990. \\ 0 & \text{o}\textit{therwise} \end{cases} \tag{4}$$

(ii) Multivariate GARCH-M Modeling

We extend Elyasiani and Mansur (1998) by employing an enhanced version of their GARCH-M model, which is in essence based on a two-factor arbitrage pricing theory (APT) model with risk (volatility) and the interest rate as the two factors. Whilst the Elyasiani and Mansur (1998) model is computationally complex, it is not without limitations. Specifically, although it does allow for mean shifts in the variance, it assumes that the effects of interest rates, and risk on excess returns are themselves unaffected by regulatory change. Our model generalises to accommodate these more complex regulatory change impacts, through dummy variables. In addition, Elyasiani and Mansur (1998) solve the model as a two-step process by obtaining the estimate of the conditional long run variance independently. By way of extension we recast the Elyasiani and Mansur (1998) model as a multivariate GARCH-M model, but to ensure the model is manageable and not overparameterised we employ the Bollerslev (1990) constant correlation restriction.[3, 4] These adoptions allow the complete model to be described by the following set of equations:[5]

$$
\begin{aligned}
ER_t &= \phi_{10} + \sum_{i=1}^{n} \phi_{1i} ER_{t-i} + \theta_1 \Delta LR_{t_{-1}} + \theta_{d2} D_2 \Delta LR_{t-1} + \theta_{d3} D_3 \Delta LR_{t-1} \\
&\quad + \gamma_1 \log(h_{11,t}) + \gamma_{d2} D_2 \log(h_{11,t}) + \gamma_{d3} D_3 \log(h_{11,t}) + \varphi_{1,yy/mm} z_{1,t} + \varepsilon_{1,t} \\
LR_t &= \phi_{20} + \sum_{j=1}^{m} \lambda_{2i} LR_{t-i} + \varphi_{2,yy/mm} z_{2,t} + \varepsilon_{2,t} \\
h_{11,t} &= \omega_{01} + \omega_{01}^{d2} D_2 + \omega_{01}^{d3} D_3 + \alpha_{11} \varepsilon_{1,t-1}^2 \\
&\quad + \beta_{11} h_{11,t-1} + \beta_{13} h_{22,t-1} + \beta_{13}^{d2} D_2 h_{22,t-1} + \beta_{13}^{d3} D_3 h_{22,t-1} \qquad (5) \\
h_{21,t} &= \rho \cdot \sqrt{h_{11,t} \cdot h_{22,t}} \\
h_{22,t} &= \omega_{03} + \alpha_{33} \varepsilon_{2,t-1}^2 + \beta_{33} h_{22,t-1} \\
&\textit{where}: \\
&\quad \varepsilon_{i,t} \mid \psi_{t-1} \sim N(0, H_t)
\end{aligned}
$$

Following Elyasiani and Mansur (1998), the intercept term, ω_{01}, and the estimated coefficient, β_{13}, (δ_1 in their model) on the lagged value of the conditional variance of the long run interest rate, $h_{22,t-1}$, (CVL_{t-1} in their model) are conditioned on the two dummy variables D_2 and D_3 in the variance equation h_{11t}. There are two advantages to this formulation. It allows estimates of the impact of changes in the long run interest rate and its volatility, on both first and second moments of the distribution of excess financial institution portfolio returns. Second it allows each of these estimates to be obtained in respect of each of the three regulatory periods previously described.

4. EMPIRICAL RESULTS[6]

(i) Key Research Questions and Hypothesis Specification

A summary of our key research questions is presented on the left-hand side of Table 2. With regard to the specification of the GARCH equation and variance effects (Panel A), we identify 5 key research questions. The first four of these involve hypotheses (H1 – H4) collectively aimed at confirming, first, the need for a heteroskedastic model and, then, that from the range of such models available, the full GARCH-M model outlined in the previous section is a desirable choice. The fifth research question gives rise to the fifth hypothesis (H5) in which the potential regulatory impact on the time-invariant component of the conditional variance equation is investigated. It is this final hypothesis that is of most interest from this first area since it explicitly engages the regulatory change phenomenon.

[TABLE 2 ABOUT HERE]

With regard to the second grouping of research questions, namely the risk-return tradeoff (Panel B), there are 2 key (related) questions. Both of these questions are directed toward assessing the role of equity return volatility as a potential factor explaining financial sector asset pricing. A set of hypotheses (H6) are developed around this theme. In particular, the outcome of testing the second half of this set of hypotheses (related to research question Q6B), are of substantial interest since again they directly address the potential impact of regulatory change. It is noteworthy that such an analysis was not possible in the Elyasiani and Mansur (1998) paper and reinforces the versatility of our empirical design.

Finally, with regard to the third area, namely interest rate effects (Panel C), we have identified a further 5 key (related) research questions that produce three sets of hypotheses (H7, H8 and H9). Two basic themes are evident. One related to assessing interest rate sensitivity and the other to assessing the impact of interest rate volatility on risk and return. As was argued for the previous two areas, substantial interest attaches to the versions of the associated hypotheses that involve the regulatory change feature (see research questions Q7B and Q8B).

The preceding discussion provides a means by which the contribution of the current paper can be gauged. Put simply, whilst each of key research questions (Q1-Q9), to varying degrees, have their counterparts in the analysis of Elyasiani and Mansur (1998), our multivariate-GARCH-M set-up permits us to perform a "richer" set of tests. This is so because of the finer parameterisation permitted with regard to the potential impact of regulatory change (see research questions Q6B, Q7B and Q8B), and allowing for a denser interaction of effects in the econometric framework. In addition, a comparison to Faff and

Howard (1999) produces a solitary area of commonality of analysis around research question Q7. In all other areas the current paper extends their analysis, and thus we argue contributes a substantial extension to the Australian literature.

The results fall naturally into four main areas of interest, namely: (a) model validation (Section 4 (ii)); (b) conditional volatility specification and shock persistence (Section 4 (iii)); (c) the risk-return trade-off (Section 4 (iv)); and (d) the interest rate effects (Section 4 (v)). To guide our journey through the progression of tests presented and discussed in the following sections and to assist us to more readily synthesise the central themes of our findings, the right hand side of Table 2 presents a concise characterisation of the outcome of each hypothesis identified.

(ii) Model Validation

An analysis of the normalised residuals of each $ER_{j,t}$ equation is presented in Table 3. This analysis indicates that the Gaussian assumptions upon which the validity of subsequent hypothesis testing depends are satisfied. The Ljung-Box test for first to twelfth order autocorrelation indicates that the normalised residuals are free from serial correlation in both first and second moments. Further, the null hypothesis of normality, which is tested using the Jarque-Bera (1981) test, cannot be rejected at any conventional level of significance. Furthermore, employing the null hypothesis $H:_0 \alpha_{11} + \beta_{11} = 1$, the stability condition ($\alpha_{11} + \beta_{11} < 1$) was tested using a χ^2 distributed Wald test with, in this case, one degree of freedom. These results confirm that the models are second order stationary because in each case the null hypothesis is rejected at any conventional level of significance. Having established the adequacy of the model as a statistical representation of the data generating process, we now turn to the discussion of the estimated coefficients.

[TABLE 3 ABOUT HERE]

(iii) Shock Persistence and the ARCH and GARCH Effects

We do not explicitly report the outcome of the first four hypotheses (H1 – H4) – rather relying on the summary coverage displayed on the right-hand side of Table 2. In general, these findings collectively confirm the need for a heteroskedastic model and, specifically, that the full GARCH-M model is a desirable choice. The only exception to this conclusion is the small banks portfolio, but for consistency purposes we continue with the full model in all cases.

The fifth research question and the associated hypothesis (H5) in which the potential regulatory impact on the time-invariant component of the conditional variance equation is investigated in Table 4. The hypothesis test (H5$_f$: $\omega_{01}^{d2} = \omega_{01}^{d3} = 0$) for the effect of deregulation upon the magnitude of the intercept (fixed component of volatility), indicates some evidence that deregulation has had a significant impact upon finance companies and to a lesser extent on small banks (at the 10% level).[7] In the case of finance companies the intercept has more than tripled in magnitude in the post-deregulation period indicating, *ceteris paribus*, that finance company returns are now on average more volatile than at any other time during the research period.

[TABLE 4 ABOUT HERE]

It is worth noting that in the case of the small bank portfolio, the volatility intercept was substantially larger in each period than that of any of the other portfolios. This indicates that the returns of small bank were, on average, more volatile than the returns of the large banks or those of the financial sector. In contrast, during the pre-deregulation period the finance companies volatility intercept was substantially smaller than that of any other portfolio. However, post-deregulation, its time invariant volatility is now indistinguishable from that of the small banks and consequently substantially larger than that of the large banks and the financial sector portfolios. Hence, we conclude that deregulation had a relatively greater impact upon the risk structures of finance companies and small banks.

In the case of small banks, the GARCH coefficient β_{11} was found to be insignificant during the modeling process indicating that this market has no memory longer than one period. Likewise, though to a lesser extent, the ARCH parameter α_{11} is not significantly different from zero. The important point to note is that in the case of the small bank portfolio, shocks do not exhibit persistence. The model for the small banks is in effect the traditional constant variance model conditioned upon periods of regulatory change and the variance of the long end of the yield curve.

(iv) The Risk-Return Trade-Off

In this model if the log of the variance of the excess returns is a priced factor then an inter-temporal trade-off between risk and return exists, and is captured by γ the coefficient of relative risk aversion (see Campbell and Hentschel, 1992). Recall that the risk referred to in this context is the total risk rather than non-diversifiable systematic risk. Consequently an increase in the total risk need not necessarily result in an increase in market risk premium. In fact, the coefficient of relative risk aversion can conceivably be of any sign or magnitude (Engle, Lilien and Robins, 1987). Table 5 reports the outcome of our analysis with regard to the question of the risk-return tradeoff.

[TABLE 5 ABOUT HERE]

Turning first to the hypothesis test ($H6_f$: $\gamma_{d2} = \gamma_{d3} = 0$) for the impact of deregulation on this risk-return trade-off. In this case it is only in respect of the financial sector and the large banks portfolios that the null hypothesis can be rejected at conventional levels of significance. Examination of the effective estimated coefficients indicates that this rejection is a consequence of small but statistically significant changes in the magnitude of the γ coefficient between the periods of regulatory change. In fact, statistical significance is synonymous with negatively signed estimated coefficients. This finding is consistent with the results of Elyasiani and Mansur (1998, p. 550) with their US sample. In the case of the small banks, risk is found to be a priced factor during the pre- and post-deregulatory subperiods. While it appears to be priced by finance companies during the deregulation period, it is not priced in either period before or after.

These results may be informed by the reasoning of Glosten, Jagannathan and Runkle (1993) who suggest that the negativity of the coefficient of relative risk aversion could be a result of a coincidence between periods of increased risk and periods in which investors are better placed to bear risk. Alternatively, if periods of increased risk, precipitate an increased proclivity to save and, assuming all assets are risky, competition may increase asset prices and consequently induce lower risk prima. In the specific context of the financial sector, Elyasiani and Mansur (1998, p. 551) suggest that if the financial sector is less susceptible to the effects of random shocks than other market sectors, then investors may in response to these shocks, shift out of the riskier sectors and into the financial sector. This substitution effect would insure that the prices of financial sector stocks would increase and consequently their risk prima would fall. In summary, it can be said that in respect of the financial sector as a whole and the large banks, an inter-temporal trade-off occurs between risk and return, which was largely unaffected by deregulation, and is an important factor in the distribution of bank stock excess returns.

(v) The Interest Rate Effects

Findings here are with some qualification, comparable with the results obtained by Elyasiani and Mansur (1998) and Faff and Howard (1999). The key elements regarding interest rate effects are presented in Table 6.

[TABLE 6 ABOUT HERE]

Consider first the hypothesis $H7_f$: $\theta_{d2} = \theta_{d3} = 0$ which tests the impact of deregulation on the effect of the lagged change in the interest rate upon the risk prima. In three of the four cases the null hypothesis is strongly rejected at all conventional levels of significance. The single exception being finance companies, where the null hypothesis marginally fails to be rejected at the five percent level. Next consider the effective estimates of the θs in each regulatory period shown in Table 6 (related to hypotheses $H7_a$, $H7_b$ and $H7_c$). In respect of the financial sector and the large banks portfolios, a common pattern is apparent. In the pre-deregulation period the coefficients are positive and statistically significant, in the deregulation period they are small and insignificant and in the post-deregulation period they are negative and significant. This result is consistent with the finding of Elyasiani and Mansur (1998, p. 555) in the US and in terms of sign, though not significance, with that of Faff and Howard (1999, p. 94-5).

The small banks portfolio presents a different picture. For small banks the estimated interest rate sensitivity for the pre-deregulation period is positive and significant, during the period of deregulation this coefficient more than doubled in magnitude and significant at the 10% level, before becoming small, negative, and insignificant in the post-deregulation period.

Consider now the impact of change in interest rate volatility upon the volatility of excess bank stock returns. The hypothesis test ($H8_f$: $\beta_{13}^{d2} = \beta_{13}^{d3} = 0$) for the impact of deregulation on the effect of the lagged variance of the interest rate upon the variance of excess returns is presented in Table 6. It can be seen from the table that in no case can the null hypothesis be rejected. Further it is only in the case of the small banks and the finance companies that the estimated coefficients for any period are statistically significant (hypotheses $H8_a$, $H8_b$, and $H8_c$). This result is inconsistent with the finding of Elyasiani and Mansur (1998, p. 550) in respect of the US where the conditional variance of both the financial sector and the large banks are affected by changes in the conditional variance of the long-run interest rate.

(vi) Discussion

The above results warrant some further discussion. The selected data set is intended to illustrate the impacts on the various classes of financial institutions as they pass through the process of deregulation. Whilst the financial sector indices and the large bank portfolios continue to be representative, the same cannot be said for the small banks and the finance companies. Many of the finance companies were subsidiaries of the banks and were constituted with the specific intent of circumventing some of the regulatory constraints of the pre-deregulation period. One of the consequences of deregulation has been the sale, failure or absorption of these finance companies to the extent that publicly listed finance companies no longer constitute a significant part of the Australian financial sector. Further, in the case of the small banks, the increased competition of the post-deregulation period has precipitated a series of mergers and acquisitions that have resulted in the reformation of this sector. This is a natural economic reaction to the increased sensitivity and risk faced by these sectors post-deregulation.

Of particular interest, given the larger proportion of total assets and customer base, are the interest rate impacts on the large banks and the financial sector indices over the three defined periods. In the pre-deregulation period a positive change in the long-term interest rate resulted in an increase in excess returns. In the deregulation period this interest rate effect declined to be insignificantly different from zero, that is, there was no relationship. However, in the post-deregulation period a positive change in the long-term interest rate resulted in a decrease in excess returns thus indicating increased interest rate risk.

These results can be explained by a number of institutional factors. During the pre-deregulation period the nexus between the banks borrowing and lending rates and market interest rates was constrained by government regulation. In turn, this resulted in a strict form of credit rationing with most of bank funds allocated to relatively low risk and long-term mortgage loans; away from high risk/return business and personal loans. In spite of these restrictions, bank equity holders were able to share in some of the benefits of riskier loans through their subsidiary finance companies. Further, banks required borrowers to meet a number of pre-specifications in their deposit behaviour in order to qualify for mortgage finance.[8] In these circumstances, as a consequence of the bank's operational environment, their expected income remained relatively unaffected because of the subsidiary substitution effects and some control over the cost of funds. The essential point is that during the pre-deregulation period the excess demand for loans was such that the banks could, over a wide range of interest rates, replace or substitute their maturing loans without increasing the risk level of their portfolios and, hence, also without affecting income. In contrast, the process of deregulation progressively re-established the relationship between the market rates of interest and the banks borrowing and lending rates and ushered in increasing levels of competition between financial institutions.

Consequently, it would seem reasonable to suggest that the relationship between the quality of a loans and the level of interest rates would increasingly become consistent with that described in the seminal papers of Stiglitz and Weiss (1981, 1983) on the rationing of credit by bankers. Briefly, Stiglitz and Weiss (1981, 1983) analyse the consequence of adverse selection and incentive effects on the loan market. In this context, adverse selection results in more borrowers with a lower preconceived probability of loan repayment being attracted into the loans market as interest rates increase. Further, higher interest rates induce these borrowers to invest the borrowed funds on projects with a higher return but a lower probability of success. Both of these impacts are a result of the residual imperfect information that remains after the banks have performed their risk evaluations. Consequently, banks will attempt to attract low-risk borrowers and ration credit in order to reduce the bank's risk exposure. This causes expected incomes of banks to rise (albeit more slowly) as interest rates increase and will occur up to a critical point when increased risk exposures will cause expected excess incomes to fall. Furthermore, this credit rationing cannot be ameliorated by increased collateral requirements because they serve as a disincentive to risk taking and may in fact exacerbate the adverse selection effect and also lower returns at a quicker rate. This analysis is extended to an Australian context by Basu (1994) who points out that the residual imperfect information after the banks have made their loan evaluations is: (i) asymmetric, and (ii) constitutes uncertainty in the Keynes-Knight sense rather than risk and, therefore, is not compensated by a higher margin of profit. Basu also argues that increasing competition will, in theory, increase borrowing rates to a greater extent than lending rates.

Given the above analysis the observed result during the post-deregulation period is consistent with the proposition that as the price of risk-free bonds falls, borrowing rates will increase at a greater rate than lending rates and so reduce operating margins and increase uncertainty for all banks. If an increase in borrowing and lending rates reduce the banks expected income sufficiently we could, in spite of the downward pressure on their share price, expect to see a decrease in the risk adjusted rate of return on bank shares. This would result in a decrease in the size of the excess return that is observed. The essential point is that during the post-deregulation periods borrowing and lending rates have become increasingly market related. If the banks do not replace the maturing loans in their portfolios their expected income will fall. If the banks do replace their maturing loans, they will change the levels of risk and uncertainty associated with those portfolios and again *ceteris paribus* their expected income may fall. Not surprisingly we see the banks increasingly focusing their resources on the provision of fee paying financial services, the demand for which is not closely related to market interest rates. Finally, whilst banks would progressively move to hedge interest rate risk it appears that this has been more successful with interest rate volatility rather than income effects.

While this explanation has focused on the observed interest rate effects in the pre- and post-deregulation periods, the period of deregulation in which the size of excess returns remained unaffected by changes in the long-term bond rate, is amenable to the same analysis. Clearly the observed result in this period is simply indicative of the banking systems progressive adjustment to the changes in their operational environment which has essentially changed from one extreme to the other.

5. CONCLUSION

The central aim of this paper was to extend the existing banking literature by analysing the dual impact of changes in the interest rate and interest rate volatility on the mean and variance of the distribution of Australian financial sector stock returns. We analyse monthly data covering the sample period 1978 to 1998, for four portfolios representing the financial institutions sector – (i) a financial institutions portfolio; (ii) a large banks portfolio; (iii) a small banks portfolio; and (iv) a finance company portfolio. Furthermore, the sample period is partitioned into a 'pre-deregulation' period; a 'deregulation' period; and a 'post-deregulation' period.

Our investigation takes place in the context of a multivariate GARCH-M model. Whilst similar to the methodology employed by Elyasiani and Mansur (1998), our empirical set-up permits us to perform a considerably richer set of tests. This is primarily captured by three of our major research questions – all having a common theme around the impact of regulatory change. Specifically, these questions are: (i) Is the role of equity return volatility in pricing affected by regulatory change? (ii) Is the interest rate sensitivity of financial sector stocks affected by regulatory change? (iii) Is the effect of interest rate volatility on the financial sector stock risk and return altered by regulatory change? In total we address twelve key research questions that are partitioned on the basis of (i) the specification of the GARCH equation and own variance effects; (ii) the risk-return trade-off; and (iii) the interest rate effects.

In summary, the main findings are as follows. First there was a consistent inter-temporal trade-off between risk and return as exemplified by the multivariate GARCH-M model. Second, deregulation significantly affected the risk structure and subsequent operations of finance corporations and small banks. Small banks had a consistently higher return volatility but the relative volatility increased after deregulation. Further, the variance of excess returns in this sector is strongly affected by the variance of the long end of the yield curve in the post-deregulation period. With respect to finance companies, the general picture is similar but with some differences. The time invariant portion of the finance company portfolio's variance was significantly affected by deregulation although it is not affected by the variance of the long end of the yield curve. More dramatically, finance corporations' sensitivity to interest rate shocks, whilst the smallest in the pre-deregulation period, increased dramatically in the post-deregulation period to match that of small banks. These factors can reasonably be associated with the subsequent reformation, rationalisation and mergers that occurred in these sectors.

Third, deregulation changed the fundamental relationship between interest rates and large bank excess returns from positive in the pre-deregulation period to negative in the post-deregulation period. However, the variance of excess returns was not significantly affected by the variance of the long end of the yield curve. These results are consistent with the predictions of Stiglitz and Weiss (1981, 1983) on loan credit rationing and general interest rate volatility hedging.

Table 1
Average Market Capitalisation and Portfolio Allocation

	Company name	Average Market Capitalisation ($AUD million)
Panel A: Large Banks Portfolio		
1	Australia and New Zealand Banking Group	4272.8952
2	Commonwealth Bank of Australia	7437.8635
3	National Australia Bank	7820.8892
4	St. George Bank	2072.9547
5	Westpac Banking Corporation	5201.0646
Panel B: Small Banks Portfolio		
1	Advance Bank Australia	691.3660
2	Bank of Melbourne	593.1998
3	Bank of Adelaide	48.1268
4	Bank of Singapore Australia	51.0000
5	Commercial Bank of Australia	231.9922
6	Commercial Banking Company of Sydney	128.9667
7	Challenge Bank	241.4067
8	Metway Bank	519.1680
Panel C: Finance Companies Portfolio		
1	Standard Chartered Bank Australia	40.4294
2	Associates Financial Services	7.1478
3	Australian Guarantee Corporation	636.7937
4	Aldershot	1.0875
5	Alliance Holdings	23.0873
6	Associated Securities	20.8584
7	AMEV-UDC Finance	12.8387
8	Beneficial Finance Corporation	30.7335
9	Co-operative Building Society of South Australia	245.0938
10	Finance and Development	2.6348
11	HDFI	11.2376
12	Lensworth Finance	13.3242
13	Merbank Corporation	5.4919
14	Mercantile Credits	50.5308
15	Network Finance	26.7787
16	Permanent Finance Corporation	12.6747
17	Prime Finance	11.1850
18	Trade Credits	6.7051

Table 2

Summary of Key Research Questions, Specification of Hypothesis Tests and Major Findings

Research Question	Null Hypothesis*	Portfolios: Fin. Sector	Large Banks	Small Banks	Fin. Cos
Panel A: GARCH Equation Specification and Own Variance Effects					
Q1: Is the return volatility of financial sector stocks time-invariant?	H1: $\alpha_{11} = \beta_{11} = \beta_{13} = \beta_{13}^{d2} = \beta_{13}^{d3} = 0$	Rej [a]	Rej [a]	Rej [a]	Rej [a]
Q2: Does the return generating process follow an ARCH specification?	H2: $\beta_{11} = \beta_{13} = \beta_{13}^{d2} = \beta_{13}^{d3} = \gamma_1 = \gamma_{d2} = \gamma_{d3} = 0$	Rej [a]	Rej [a]	Rej [a]	Rej [a]
Q3: Does the return generating process follow an ARCH-M specification?	H3: $\beta_{11} = \beta_{13} = \beta_{13}^{d2} = \beta_{13}^{d3} = 0$	Rej [a]	Acc [d]	Rej [a]	Rej [a]
Q4: Does the return generating process follow a GARCH specification?	H4: $\beta_{13} = \beta_{13}^{d2} = \beta_{13}^{d3} = \gamma_1 = \gamma_{d2} = \gamma_{d3} = 0$	Rej [a]	Rej [a]	Rej [a]	Rej [a]
Q5: Does the process of regulatory change impact financial sector risk and return through changes in the time-invariant component of volatility?	H5$_d$: $\omega_{01}^{d2} = 0$	- [b]	- [b]	- [b]	n.a.
	H5$_e$: $\omega_{01}^{d3} = 0$	- [b]	- [b]	- [b]	Pos [e]
	H5$_f$: $\omega_{01}^{d2} = \omega_{01}^{d3} = 0$	Acc [d]	Acc [d]	Acc [d]	n.a.
Panel B: Risk-Return Trade-off					
Q6A: Is equity return volatility a significant factor in financial sector asset pricing?	H6$_a$: $\gamma_1 = 0$	Neg [c]	Neg [c]	Pos[c]	- [b]
	H6$_b$: $\gamma_1 + \gamma_{d2} = 0$	Neg [c]	Neg [c]	-	Neg [c]
	H6$_c$: $\gamma_1 + \gamma_{d3} = 0$	Neg [c]	Neg [c]	Pos[c]	- [b]
Q6B: Is the role of equity return volatility in pricing affected by regulatory change?	H6$_d$: $\gamma_{d2} = 0$	- [b]	Neg [c]	- [b]	- [b]
	H6$_e$: $\gamma_{d3} = 0$	- [b]	- [b]	- [b]	- [b]
	H6$_f$: $\gamma_{d2} = \gamma_{d3} = 0$	Rej [a]	Rej [a]	Acc [d]	Acc [d]

Notes: * In cases where the null hypothesis is period specific, it is denoted by an 'a' subscript ('pre-deregulation' period); a 'b' subscript ('deregulation' period); and a 'c' subscript ('post-deregulation' period). Further, where the hypothesis is a test across periods it is denoted by a 'd' subscript ('pre-deregulation' versus 'deregulation'); an 'e' subscript ('pre-deregulation' versus 'post-deregulation'); and an 'f' subscript ('pre-deregulation' versus 'regulation' versus 'post-deregulation'). Lack of a subscript indicates a general test.

[a] "Rej" indicates that, in the case of a joint hypothesis, the null hypothesis is rejected.
[b] "-" indicates that the null hypothesis cannot be rejected.
[c] "Neg" indicates that the null hypothesis is rejected and that the estimated coefficient is negative.
[d] "Acc" indicates that, in the case of a joint hypothesis, the null hypothesis cannot be rejected.
[e] "Pos" indicates that the null hypothesis is rejected and that the estimated coefficient is positive.

Table 2

Summary of Key Research Questions, Specification of Hypothesis Tests and Major Findings (cont.)

Research Question	Null Hypothesis*	Portfolios: Fin. Sector	Large Banks	Small Banks	Fin. Cos
Panel C: Interest Rate Effects					
Q7A: Are the returns of financial sector stocks sensitive to interest rate changes?	$H7_a$: $\theta_1 = 0$	Pos [e]	Pos [e]	Pos [e]	- [b]
	$H7_b$: $\theta_1 + \theta_{d2} = 0$	- [b]	- [b]	_[b]	- [b]
	$H7_c$: $\theta_1 + \theta_{d3} = 0$	Neg [c]	Neg [c]	- [b]	- [b]
Q7B: Is the interest rate sensitivity of financial sector stocks affected by regulatory change?	$H7_d$: $\theta_{d2} = 0$	- [b]	- [b]	- [b]	- [b]
	$H7_e$: $\theta_{d3} = 0$	Neg [c]	Neg [c]	Neg [c]	Neg [c]
	$H7_f$: $\theta_{d2} = \theta_{d3} = 0$	Rej [a]	Rej [a]	Rej [a]	Rej [a]
Q8A: Does interest rate volatility have any effect on financial sector stock risk and return?	$H8_a$: $\beta_{13} = 0$	- [b]	- [b]	Neg [c]	Neg [c]
	$H8_b$: $\beta_{13} + \beta_{13}^{d2} = 0$	- [b]	- [b]	- [b]	- [b]
	$H8_c$: $\beta_{13} + \beta_{13}^{d3} = 0$	- [b]	- [b]	Neg [c]	- [b]
Q8B: Is the effect of interest rate volatility on financial sector stock risk and return altered by regulatory change?	$H8_d$: $\beta_{13}^{d2} = 0$	- [b]	- [b]	- [b]	- [b]
	$H8_e$: $\beta_{13}^{d3} = 0$	- [b]	- [b]	- [b]	- [b]
	$H8_f$: $\beta_{13}^{d2} = \beta_{13}^{d3} = 0$	Acc [d]	Acc [d]	Acc [d]	Acc [d]
Q9: Can we dismiss the total effect of interest rates on financial sector stock risk and return – either through interest rate sensitivity or through interest rate volatility?	$H9_a$: $\theta_1 = \beta_{13} = 0$	Rej [a]	Rej [a]	Rej [a]	Rej [a]
	$H9_b$: $\theta_1 + \theta_{d2} = \beta_{13} + \beta_{13}^{d2} = 0$	Acc [d]	Acc [d]	Acc [d]	Acc [d]
	$H9_c$: $\theta_1 + \theta_{d3} = \beta_{13} + \beta_{13}^{d3} = 0$	Rej [a]	Acc [d]	Rej [a]	Acc [d]

Notes: * In cases where the null hypothesis is period specific, it is denoted by an 'a' subscript ('pre-deregulation' period); a 'b' subscript ('deregulation' period); and a 'c' subscript ('post-deregulation' period). Further, where the hypothesis is a test across periods it is denoted by a 'd' subscript ('pre-deregulation' versus 'deregulation'); an 'e' subscript ('pre-deregulation' versus 'post-deregulation'); and an 'f' subscript ('pre-deregulation' versus 'deregulation' versus 'post-deregulation'). Lack of a subscript indicates a general test.

[a] "Rej" indicates that the null hypothesis is rejected.
[b] "-" indicates that the null hypothesis cannot be rejected.
[c] "Neg" indicates that the null hypothesis is rejected and that the estimated coefficient is negative.
[d] "Acc" indicates that the null hypothesis cannot be rejected.
[e] "Pos" indicates that the null hypothesis is rejected and that the estimated coefficient is positive.

Table 3

Model Validation – Key Diagnostics

Panel A: ER Equation					
Residual Analysis					
Test Statistic	Test	Financial Sector Portfolio[d]	Large Banks Portfolio[d]	Small Banks Portfolio[d]	Finance Companies Port[d]
$Q(12)-\varepsilon_{1,t}/h_{11,t}$	Ljung-Box[a]	4.17[0.98]	5.78[0.92]	19.90[0.60]	17.14[0.14]
$Q(12)-\varepsilon^2_{1,t}/h^2_{11,t}$	Ljung-Box[b]	11.00[0.52]	10.47[0.57]	19.48[0.70]	16.79[0.16]
$JB-\varepsilon_{1,t}/h_{11,t}$	Jacque-Bera[c]	0.61[0.73]	0.56[0.75]	5.91[0.05]	3.79[0.15]
Hypothesis Tests - Wald Test Statistics					
Null Hypothesis	Description	Financial Sector Portfolio[d]	Large Banks Portfolio[d]	Small Banks Portfolio[d]	Finance Companies Port[d]
$\alpha_{11}+\beta_{11}=1$	Stability Test	30.82[0.00]	7.07[0.00]	n.a.	4.91[0.02]
Pane B: LR Equation					
Residual Analysis					
Test Statistic	Test	Financial Sector Portfolio[d]	Large Banks Portfolio[d]	Small Banks Portfolio[d]	Finance Companies Port[d]
$Q(12)-\varepsilon_{2,t}/h_{22,t}$	Ljung-Box[a]	11.72[0.46]	11.58[0.47]	11.70[0.46]	11.48[0.48]
$Q(12)-\varepsilon^2_{2,t}/h^2_{22,t}$	Ljung-Box[b]	6.63[0.88]	5.99[0.91]	5.70[0.93]	7.35[0.83]
$JB-\varepsilon_{2,t}/h_{22,t}$	Jacque-Bera[c]	1.13[0.56]	1.17[0.55]	1.03[0.59]	1.34[0.51]
Hypothesis Tests - Wald Test Statistics					
Null Hypothesis	Description	Financial Sector Portfolio[d]	Large Banks Portfolio[d]	Small Banks Portfolio[d]	Finance Companies Port[d]
$\alpha_{33}+\beta_{33}=1$	Stability Test	5.32[0.02]	5.59[0.01]	58.6[0.00]	6.21[0.01]

Notes:

This table provides some basic tests of the behavior of the normalised residuals produced by the multivariate M-GARCH model.

[a] This is the Ljung-Box test of autocorrelation (to lag 12) in the normalised residuals

[b] This is the Ljung-Box test of autocorrelation (to lag 12) in the squared normalised residuals

[c] This is the Jacque-Bera test of the normality of the normalised residuals

[d] The p-value for each test statistic is contained in square brackets

Table 4

Selected Key Results on Variance Effects

Panel A: GARCH Equation Coefficient Estimates

Estimated Coefficient	Description	Financial Sector	Large Banks	Small Banks	Finance Companies
ω_{01}	Pre-Deregulation	0.0009	0.0017	0.0027	0.0007
		(6.94)**	(2.76)**	(9.34)**	(3.97)**
$\omega_{01} + \omega_{01}^{d2}$	Deregulation	0.0013	0.0018	0.004	-
		(3.33)**	(2.70)**	(5.19)**	-
$\omega_{01} + \omega_{01}^{d3}$	Post-Deregulation	0.0009	0.0014	0.0025	0.0024
		(4.71)**	(2.80)**	(5.26)**	(3.74)**
α_{11}	ARCH	0.04670	0.0417	0.064	0.58480
		(5.568)**	(2.77)**	(0.964)	(13.77)**
β_{11}	GARCH	0.4399	0.3292	n.a.	0.3058
		(4.66)**	(1.39)	n.a.	(10.15)**
$\alpha_{11}+\beta_{11}$	Persistence Measure	0.4866	0.3709	n.a.	0.8908
		(5.26)**	(1.57)	n.a.	(18.08)**

Panel B: Hypothesis Tests - Wald Test Statistics

Null Hypothesis	Description	Financial Sector	Large Banks	Small Banks	Finance Companies
$\omega_{01}^{d2} = 0$	$H5_d$	1.28[0.26]	0.35[0.55]	2.81[0.09]	n.a
$\omega_{01}^{d3} = 0$	$H5_e$	0.30[0.59]	2.01[0.16]	0.22[0.63]	8.98[0.00]
$\omega_{01}^{d2} = \omega_{01}^{d3} = 0$	$H5_f$	1.68[0.43]	2.57[0.28]	2.83[0.24]	n.a

Notes: t-statistics are in ( ) while p-values are in [ ]
* and/or ** indicates significance at the 5 percent and 1 percent levels respectively.

Table 5

Results for the Risk Return Trade Off

Panel A: Estimates of the Trade Off Parameter					
Estimated Coefficient	Description	Financial Sector	Large Banks	Small Banks	Finance Companies
γ_1	Pre-Deregulation	-0.2343	-0.2435	0.0033	-0.0008
		(-9.19)**	(-4.13)**	(7.82)	(-0.90)
$\gamma_1+\gamma_{d2}$	Deregulation	-0.2533	-0.2520	0.0032	-0.0028
		(-7.47)**	(-4.18)**	(1.83)	(-2.61)**
$\gamma_1+\gamma_{d3}$	Post-Deregulation	-0.2392	-0.2364	0.0029	-0.0001
		(-8.21)**	(-4.21)**	(4.57)	(-0.05)
Panel B: Hypothesis Tests - Wald Test Statistics					
Null Hypothesis	Description	Financial Sector	Large Banks	Small Banks	Finance Companies
$\gamma_{d\,2} = 0$	$H6_d$	2.96 [0.09]	5.42 [0.02]	0.01[0.93]	2.95[0.09]
$\gamma_{d3} = 0$	$H6_e$	1.04 [0.31]	2.94 [0.09]	0.59[0.44]	0.17[0.68]
$\gamma_{d\,2} = \gamma_{d3} = 0$	$H6_f$	5.59 [0.06]	10.31 [0.01]	0.59[0.74]	3.27[0.19]

Notes: t-statistics are in ( ) while p-values are in [ ]

* and/or ** indicates significance at the 5 percent and 1 percent levels respectively.

Table 6

Results for the Interest Rate Effects

Panel A: Estimates of Interest Rate Sensitivity and Interest Rate Volatility Parameter

Estimated Coefficient	Description	Financial Sector	Large Banks	Small Banks	Finance Companies
θ_1	Pre-Deregulation	0.2821	0.2669	0.1987	0.1132
		(3.43)**	(2.69)**	(4.95)**	(1.08)
$\theta_1+\theta_{d2}$	Deregulation	0.0870	0.0538	0.447	0.2251
		(0.64)	(0.39)	(1.75)**	(1.25)
$\theta_1+\theta_{d3}$	Post-Deregulation	-0.2522	-0.2238	-0.1406	-0.4641
		(-2.65)**	(-2.10)*	(-1.61)	(-1.42)
β_{13}	Pre-Deregulation	-0.0638	-0.1340	-0.806	-0.2885
		(-1.54)	(-1.18)	(-23.44)**	(-3.31)**
$\beta_{13}+\beta_{13}^{d2}$	Deregulation	0.1470	0.1682	-0.331	0.6035
		(0.88)	(0.61)	(-0.39)	(0.60)
$\beta_{13}+\beta_{13}^{d3}$	Post-Deregulation	-0.0113	-0.0039	-1.071	0.0033
		(-0.14)	(-0.02)	(-6.75)**	(0.00)

Panel B: Hypothesis Tests - Wald Test Statistics

Null Hypothesis	Description	Financial Sector	Large Banks	Small Banks	Finance Companies
$\theta_{d2} = 0$	$H7_d$	1.53 [0.22]	1.61 [0.21]	0.99[0.38]	0.61[0.44]
$\theta_{d3} = 0$	$H7_e$	18.18 [0.00]	11.04 [0.00]	20.14[0.00]	4.57[0.03]
$\theta_{d2} = \theta_{d3} = 0$	$H7_f$	18.20 [0.00]	11.06 [0.00]	23.21[0.00]	5.37[0.07]
$\beta_{13}^{d2} = 0$	$H8_d$	1.54 [0.21]	1.06 [0.30]	0.33[0.57]	0.73[0.39]
$\beta_{13}^{d3} = 0$	$H8_e$	0.38 [0.54]	0.49 [0.48]	3.84[0.05]	0.11[0.74]
$\beta_{13}^{d2} = \beta_{13}^{d3} = 0$	$H8_f$	1.82 [0.4]	1.37 [0.5]	5.41[0.07]	2.16[0.34]
$\theta_1 = \beta_{13} = 0$	H9a	15.86 [0.00]	8.35 [0.02]	59.3[0.00]	29.15[0.00]
$\theta_1+\theta_{d2}= \beta_{13}+\beta_{13}^{d2} = 0$	H9b	0.96 [0.62]	0.45 [0.8]	3.1[0.21]	3.35[0.19]
$\theta_1+\theta_{d3}= \beta_{13}+\beta_{13}^{d3} = 0$	H9c	7.29 [0.03]	4.42 [0.11]	92.9[0.00]	3.41[0.18]

Notes: t-statistics are in ( ) while p-values are in [ ]

* and/or ** indicates significance at the 5 percent and 1 percent levels respectively.

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[1] The advantage of forming portfolios in this manner is that it provides an efficient way of amalgamating a disparate amount of information about bank stock returns and filters out the effects of transitory shocks to individual firms that might otherwise significantly distort the results. However, the disadvantage of this approach is of course, that it may also filter out any key dissimilarity in the return generating processes of the individual banks within each portfolio.

[2] As outlined shortly, the omitted case – namely, the 'pre-deregulation' period – will be captured as the base case in order to avoid the 'dummy variable trap'.

[3] In the basic version of the model ignoring regulatory subperiods, this simplification reduces the number of estimated parameters from twenty-one to eight; a considerable reduction in the computational complexity of the model. Moreover, the computational simplicity is enhanced threefold, once the subperiod specification is entertained.

[4] As a compromise, we test the stability of the correlations across subperiods and find that the stability hypothesis can only be rejected in the case of our small banks portfolio. Accordingly, with regard to the small banks analysis, the results reported in the remainder of the paper allow for the cross period instability of the correlation by permitting it to differ across subperiods. Details are available from the authors upon request.

[5] The specification includes an autoregressive model for excess returns (ER_t), determined using the techniques described by Box and Jenkins (1976), to ensure that the residuals of the model are spherical. We find that the order of the autoregressive component of the mean equation for excess returns (n) and long run interest rates (m) is zero in respect of each of the four subsets of the market investigated. This finding indicates that the Australian data used here is consistent with the theoretical assumption that returns are independent and is in contrast with the findings of Elyasiani and Mansur (1998, p. 551) in respect of the US. In addition, note that both equations now include z vectors that contain idiosyncratic dummy variables coincident with exogenous shocks.

[6] To facilitate discussion of these empirical results, the most relevant estimated coefficients and test statistics are packaged into tables and are presented as the discussion proceeds. Also, for convenience and clarity of exposition the effective estimated coefficients for each regulatory period have, where applicable, been calculated from the model that was actually estimated. For example, $\theta_1+\theta_{d2}$ provides an estimate of the effect of a change in ΔLR_{t-1} during the period of deregulation, while, $\theta_1+\theta_{d3}$ provides a similar estimate for the post-deregulation period.

[7] Unfortunately, in the case of the finance companies, the intercept terms for the pre-deregulation and the deregulation periods could not be distinguished as a result of computational difficulties.

[8] For example, the requirement to maintain minimum levels of funds in low yielding savings accounts for specified periods of time.