HAVE NEW ZEALAND BANKS REALLY BECOME MORE EFFICIENT?

David Tripe
Centre for Banking Studies
Massey University
Palmerston North

Phone: +64 6 350-5799 ext 2337
Fax: +64 6 350-5651

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Abstract:

This paper explores the extent of efficiency improvements achieved by New Zealand banks over the period 1996 to 2001, using data envelopment analysis (DEA), on a time-series, rather than cross-sectional basis.

The paper identifies a number of issues that arise with use of DEA, including that approximately 60% of the apparent improvement in efficiency across all banks which together dominate the retail market, averaged across the two models used, is a consequence of a fall in the general level of interest rates. There is, however, a significant unexplained portion of efficiency improvement, which may be due to either management effort to improve bank efficiency or technical progress.

(1) Introduction

All round the world, efforts are being made to achieve improvements in efficiency in banking. The idea is that if banks are more efficient, they will be able to run at lower cost, leading to improved profitability and better returns to shareholders. Banks are not the only businesses engaged in this pursuit, of course, but bank managements are inclined to be single-minded in the belief that cost cutting will be the answer to problems in bank performance. Bank management typically discuss cost performance in terms of two ratios – the ratio of (non-interest) operating costs to (average) total assets, and the ratio of operating costs to gross income (net of interest expense).

Both of these ratios have limitations as measures of cost performance, particularly in that they are both capable of being manipulated through changing accounting practices, and because they take no account of differences between the pattern and structure of business undertaken by the banks whose ratios are being compared. The cost to income ratio is probably the more popular with bank managements, and it has an intuitive appeal in terms of incorporating both key elements in the profit equation, so that, other things being equal, a lower cost to income ratio should imply greater profitability.[1] Banks in New Zealand and Australia have achieved significant reductions in their cost ratios during the 1990s, with a major factor in this being reductions in the number of staff. This is a different outcome from that observed, for example, in the United States (based on OECD figures for bank profitability), and there is therefore a question as to whether this may be a consequence of the relatively concentrated banking markets in Australia and New Zealand, with small number of major participants.

To take account of the different mix and pattern of business from bank to bank, therefore, we cannot confine ourselves to looking at simple ratios, but must look at financial firms on a multiple input and multi-product basis.[2] Banks use a mixture of inputs to produce a mixture of outputs, and their reported aggregate cost figures will depend just as much on the mix of inputs and outputs as on the rate at which they use

[1] For a more extensive discussion of deficiencies in the cost to income ratio, see Tripe (1998).
[2] Berger & Humphrey (1992), pp 559-560, provide an outline of why analysis of a bank's costs should include both interest and non-interest costs.

those inputs to produce the outputs (Mester, 1987). Against this background, a financial firm may be said to be operating inefficiently if it can produce more output without a corresponding relative increase in inputs, or if it can reduce its use of inputs without a corresponding relative decrease in output.

This paper sets out to explore an issue uncovered in the one previous piece of research undertaken which applied efficiency analysis techniques to the New Zealand banking market (Su & Tripe, 2001). That research found that the efficiency scores recorded by New Zealand banks had been declining since 1996, an outcome which would appear to be inconsistent with the reported efforts by New Zealand banks to improve their efficiency. This research will thus look at quarterly data for New Zealand banks for the period June 1996 to June 2001.

The rest of this paper proceeds as follows. In the next section we discuss the methods of efficiency analysis in banks in general terms, and make reference to previous studies. In section 3 we describe the methodology and data used for this study, the first stage results of which are reported and discussed in section 4. In response to these findings, section 5 reports on and discusses the further analysis that was undertaken. The final section strives to draw conclusions from the analysis undertaken, and suggests ways in which this line of research may be pursued further in the future.

(2) Some background to efficiency analysis

Efficiency can be discussed in a variety of different forms. Traditional microeconomic theory has long taught us about economies of scale, whereby increased volumes of output are supposed to be able to be produced with less than proportionate increases in quantities of inputs. In due course, however, economies of scale will be exhausted, and increased output will require more than proportionate increases in inputs, a situation described as diseconomies of scale.

Another type of efficiency is economies of scope. The essence of these is that firms should be able to produce multiple outputs from the same group of inputs at lower cost, in terms of inputs, than if they specialised in producing only one type of output.

In a banking context, we might be looking at a situation where a firm produced both loans and deposit services, using the same staff and branch networks, rather than specialising in just one of these functions by itself.

As described in the previous paragraphs, these discussions of economies of scale and scope assume a single form of production function which applies to all firms in the market: if two firms are producing at the same mix of outputs at the same volume, their costs will be the same. This may not, however, be a reasonable assumption, and we thus come to the concept of X-efficiency, which itself has two components – technical efficiency and allocative efficiency. Technical efficiency might be conceived in simple terms as a measure of wastefulness, while allocative efficiency tends to look at whether the best combination of inputs is being used, having particular regard to their relative cost. If New Zealand banks have improved their efficiency during the latter part of the 1990s, it is expected that this would have been achieved by changes in their X-efficiency.

Attempts to specify and measure X-efficiency in particular generally occur relative to an efficiency frontier, with firms' efficiency being defined in terms of their relative distance from the frontier (which the becomes the benchmark for optimum performance). Previous research has suggested that variations in banks' X-efficiency are in fact much more important than any efficiency effects that might arise from efforts to realise economies of scale or scope (Berger, Hunter & Timme, 1993). The rest of this paper will thus be concentrated on issues relating to X-efficiency and efficient frontiers.

Because there is no agreed set of engineering relationships defining a standardised set of production processes in banking, there is no simple readily agreed approach for specifying the efficiency frontier. Attempts to determine the position of the efficiency frontier are thus dependent on use of accounting information and any other measures of input usage or output volume that may be available. Given this, Berger & Humphrey (1997) note that there have been at least five different approaches to determining the efficiency frontier.

The three main parametric approaches to specification of the efficiency frontier are the stochastic frontier approach (SFA), the distribution-free approach (DFA) and the thick frontier approach (TFA), while the two non-parametric approaches are data envelopment analysis (DEA) and the free disposal hull (FDH) method.[3] The major difficulty with the non-parametric approaches is that they cannot identify random error arising from either measurement error or extraordinary financial performance (which may or may not arise from accounting practice). The parametric approaches are better able to deal with random error, and they are the distinguished essentially by the way in which this random error is broken down to allow identification of inefficiency.

An issue with the parametric approaches is that they have to specify a functional form for the cost, profit or production relationship between inputs, outputs and environmental factors. The problem with specifying a functional relationship is that it presupposes the shape of the efficiency frontier, and for the translog approximation in particular, this has the potential to generate misleading interpretations in relation to economies of scale and scope (Berger & Humphrey, 1997; McAllister & McManus, 1993).

The only previous study of the New Zealand market (Su & Tripe, 2001) was based on the methodology used by Avkiran (1999) in his study of the Australian banking market. In both these cases, the frontier technique used was DEA, the technique also used by Sathye (2001), who noted its use in prior studies where the sample size was small. The other previous study looking at X-efficiencies in Australian banking has been Walker (1998), who used a fixed effects version of SFA,[4] although he identified the difficulty posed by the limited number of banks for establishing a suitable efficient frontier.

[3] Lists of approaches to frontier analysis often omit the FDH approach, which may be regarded as a special case of DEA. Berger & Humphrey (1997) would suggest that DEA was more widely used, at least in banking.

[4] A number of earlier studies have also been reported, such as Valentine & Williamson (1982), but these were not focused on X-efficiency, while there have also been a number of studies of non-bank financial institutions, such as Esho & Sharpe (1996), Garden & Ralston (1999) and Worthington (1998).

Another important classification of approaches to modelling bank efficiency is the distinction between the production and intermediation models.[5] Under the production approach, banks are regarded as using labour and capital to produce deposits and loans (with outputs potentially being measured by number of accounts, rather than dollars). The intermediation approach sees deposits as connected to loans: limitations in the data available in the New Zealand and Australian markets tend to mean that this is the only approach available to us here. A further consideration, at least in the New Zealand market, is that it is often difficult and not meaningful to distinguish deposits from other funding (Tripe, 1999): the intermediation approach typically includes aggregate interest cost as an input, and does not require a distinction to be made between different sources of funding.

(3) Methodology and Data

In terms of the previous discussion, and having regard to the relatively small number of banks in the New Zealand market, we have decided to use the DEA approach for this study. We have also noted a preference for using the intermediation approach, having regard to the available data, which will be derived from New Zealand banks' quarterly disclosure statements, which have been produced (in terms of requirements) since the end of the March quarter 1996.

These data are subject to some limitations, but they nonetheless provide for a time series analysis of a number of potential input and output variables for quarters ending from 30 June 1996 to 30 June 2001. Because of a change in accounting policy, data for the ANZ Banking Group (NZ) Ltd (ANZ) for the quarter ending 31 December 1997 are not useable for all analyses, but we otherwise have 21 quarters of data available for ASB Bank (ASB), Bank of New Zealand (BNZ), Citibank, Hong Kong Bank (HSBC), the National Bank of New Zealand (NBNZ), TSB Bank (TSB) and WestpacTrust.[6] In due course we will seek to analyse the performance of these banks

[5] A variety of other approaches are recorded – see, for example, Favero & Papi (1995) – but these may be regarded as special cases within these broader classifications.

[6] These are the only banks out of the 16 registered as at November 2001 which have been registered and conducting business in a significant way throughout the period under analysis. Rabobank New Zealand branch commenced business shortly before 30 June 1996, but the scale and scope of that business was only quite limited until the end of 1997. The business of Citibank and HSBC has been predominantly in wholesale markets (and in Citibank's case, wholly in wholesale markets since it sold

on both a cross-sectional and time-series basis, and we will thus want to economise on use of both input and output variables so as to enhance the discriminatory power of the analysis. In this respect, we prefer to limit ourselves to two input and two output variables (although in subsequent cross-sectional analysis we would, in practice, expect to be able to expand out sample beyond the 8 banks listed above).[7]

The variables used in other small sample analyses in the Australian and New Zealand markets are summarised in Table 1. Data for staff numbers are not available on a quarterly basis, which precludes their use as an input variable. Capital is not a suitable variable in New Zealand, as a number of the banks to be reviewed operate as branches, and therefore have no capital in New Zealand. Difficulties also arise in using deposits as either an input or output variable, because of difficulties in their specification, particularly in the so-called off-quarters.[8]

For our initial analysis, we have therefore chosen two models (although we note that there are a number of other models that would be possible, and which we will explore in subsequent analysis). These models are described as Models 1 and 2, which both have interest expense and non-interest expense as inputs. Model 1 has (total) interest income and non-interest income as outputs, while Model 2 has net interest income and non-interest income as outputs. The input and output variables are all expressed as percentages of average total assets, which avoids the need to adjust for changes in the general level of prices.[9]

We also use a standard, default, constant returns to scale model, as the literature would suggest that scale economies should not be a major factor for banks of the size being explored in this study. This assumption will also be important for subsequent cross-sectional analysis, where variable returns to scale models can be misleading for banks of different sizes (which then become hard to compare with each other). If there

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its retail business to AMP Banking in 1998), but these banks are still included on the basis of their reasonable scale of business while they also expand the size of our sample.

[7] Berger & Humphrey (1997) suggest that one of the reasons why studies of bank branch performance generate significant numbers of branches with 100% efficiency is that the number of variable reviewed is too large, such that the scope for individual branches to clearly dominate or be dominated by some other branch in enough dimensions is quite limited (p 206).

[8] The loss that this imposes would be likely to be less significant than in the United States environment as non-interest-bearing deposits are not, in general, significant.

[9] Inflation was in fact quite low during the period studied.

were economies of scale, we would in any case expect these to be observed in a relationship between efficiency and total assets, a point discussed later in the paper.

(4) Initial Analysis and Results

Initial analysis using DEA was undertaken on a time-series basis. Results for efficiency for each of the banks analysed are reported in Tables 2 and 3. The symbol N/A is used for the ANZ case where data were not meaningful because of changed accounting policy (the December quarter 1997) and for those Citibank cases where one of the output variables was a negative number.[10]

Two features are immediately evident from these results. In the first place, we can see that Model 1 generates higher efficiency scores, on average, than does Model 2. Secondly, there appears to be a trend for efficiency to improve over time, a result which appears to contradict the findings of Su and Tripe (2001), who used what is in effect Model 2, and who found evidence for a decline in banks' relative efficiency scores. The correlations between the efficiency scores from each model and a time trend variable are reported in Table 4.

Note that the positive values for the correlation coefficients would appear to be evidence in support of the proposition that New Zealand banks have become more efficient over time. They are also consistent with the findings for the impact of time trend reported in To and Tripe (2001), in their exploration of factors affecting the performance of foreign-owned banks in New Zealand.

These findings are, however, to a significant extent, a logical outcome of the use of DEA and frontier analysis in general, subject to the further consequences of a reduction in the general level of interest rates over the period studied. We can explain each of these results in turn.

We thus look at the impact of interest rate changes, and at the differences between Models 1 and 2, with Model 2 reporting lower levels of efficiency. The difference

[10] This has the effect of invalidating the relevant DEA calculations for the software used, which was Banxia Frontier Analyst.

between the two models is that Model 1 uses total interest income as an output, whereas Model 2 uses net interest income. Suppose as a simplifying assumption that net interest income is constant over time, and that we look at two separate time periods, one of which is characterised by high interest rates and the other by low interest rates. All other aspects of bank cost and efficiency (i.e. non-interest expense and non-interest income) are unchanged.

DEA, and the models used in this study in particular, rely in essence for efficiency measurement on the ratio between inputs and outputs. Let us pick some numbers as examples – an aggregate average cost of funds of 8% in the high interest case and a cost of funds of 4% in the low interest rate case, with a net interest income of 2% in each case.[11] For Model 1 we thus have, in the high interest case, an interest cost of 8% being used to generate interest income of 10%, and in the low interest environment, interest expense of 4% being used to generate interest income of 6%. The ratio of the output price to input price is thus higher (and the bank will therefore appear to be more efficient) when interest rates are lower.

In the Model 2 case, the relative conversions are input prices of 8% and 4% to generate an output of 2%, which is an even bigger change in the ratio. Efficiency measures from Model 2 will thus be even more sensitive to changes in interest rates than will efficiency measures from Model 1: because of the changes in interest rates over the period studied, it is therefore to be expected that there should be greater variation in efficiency in Model 2 than in Model 1.

The other interesting finding from the results reported in Tables 2 and 3 was that efficiency had apparently increased, contrary to the findings of Su & Tripe (2001). This would seem to be a general consequence of the use of frontier analysis. In the Su & Tripe study, as in Avkiran (1999), which provides its methodological underpinning, efficiency frontiers are determined for each time period in isolation, and each bank's performance is assessed relative to other banks in the same time period. This approach cannot tell us anything about how the efficiency of banks changes over time: all it can

[11] These numbers are not inconsistent with figures actually observed in New Zealand over the period analysed.

provide us with is a trend in relative efficiency ranking. There is thus no inconsistency in the results.

In the next part of this paper we look to try and measure the relative significance of factors which might be responsible for the apparent increase in efficiency. Part of the efficiency improvement may be attributed to falling interest rates, but as previously noted, banks may be benefiting from increased scale, while bank managements might argue that efficiency has been improved through their own management expertise, assisted by technological change.

(5) Further exploration of efficiency improvements

We have so far merely asserted that the general level of interest rates has fallen over the period of the study. Chart 1 demonstrates the truth of this assertion by showing the trend in the average 90-day bill rate for each quarter, with the 90-day bill rate being regarded as a reasonable proxy for the general level of interest rates as they impact on New Zealand banks.

To investigate the factors behind the observed efficiency improvements, an obvious approach is to run regressions with efficiency as the response variable, and with interest rates, the time trend and total assets as explanatory variables. However, if a bank's assets have been increasing over time, it is highly likely that total assets and the time trend will be correlated with each other, while we have already been led to expect (from Chart 1) that there will be some degree of (negative) correlation between the time trend and interest rates.

The approach taken is therefore as follows. We first run a simple regression of efficiency score from each model against the general level of interest rates, and then add the time trend and total assets variables, sequentially. The relative regression models will be referred to as A, B and C. The results, in terms of coefficients of determination for the regressions, parameter estimates and their t-statistics are reported in Table 5. Multicollinearity is identified if the variance inflation factors for the additional explanatory variables are greater than 10, and no result is reported.

It might reasonably be argued that, because our response variable is efficiency which must be in the range 0 to 1 (100%), we ought to be using logit regression. The actual fitted values obtained from the regression are not of particular interest, however, and in any case the estimated constants are not significantly greater than 100. It is therefore considered that the simple and OLS regressions used provide adequate outcomes, while offering us a coefficient of determination that is simple to interpret.

We have four cases from the regressions undertaken where significant Durbin-Watson statistics are reported at the 5% level, and two more cases where the Durbin-Watson statistic is in the zone of uncertainty. We are, however, unconvinced that this evidence for serial correlation of residuals is a problem. A bank's performance in one quarter is unlikely to be wholly independent of its performance in previous or subsequent quarters, and we have therefore retained the affected regression results.

Table 5 shows multicollinearity problems arising from the correlation between time trend and total assets for all banks except Citibank and HSBC. A review of the data for these two banks shows that, in contrast with the other banks studied, they have not been growing their assets. It is noted, however, that the coefficients for total assets are not significant in any case: we therefore have no evidence specific to these two banks to support the existence of economies of scale.

Another interesting finding shown in Table 5 is that there is considerable variation in the results reported for some banks in particular, with relatively low R^2 values shown for ASB, BNZ and Citibank in particular (and with coefficients for interest rate as an explanatory variable not significant in Model 1). Could it therefore be that our argument that there ought to be a relationship between efficiency and interest rates is wrong? We have explored this further by investigating the efficiency of banks with predominantly retail business as if they were a single entity[12].

Results are reported in Table 6, and these support the existence of relationships between efficiency and both interest rates and time trend. Why is the performance of these other banks, and BNZ in particular, therefore exceptional?

[12] Banks included in this group are ANZ, ASB, BNZ, Countrywide Bank (up until its acquisition by the NBNZ in 1998), NBNZ, TSB and WestpacTrust.

If we refer back to the results reported in Table 4, we find that, under Model 1, BNZ's efficiency was only very weakly correlated with the time trend, while under Model 2, the correlations with time trend for ASB, BNZ and Citibank were also relatively weak. The efficiency trend under both models of the BNZ is plotted in Chart 2, and we can see that the BNZ has in fact shown very little improvement in efficiency over the period in question (in contrast to the other banks whose performance is reviewed). A similar, although less marked, effect can also be observed for ASB (with these effects also observable in Tables 2 and 3).[13]

This result raises an interesting question. In view of the obvious conceptual relationship between falling interest rates and efficiency scores, why has the BNZ in particular not shown more of an improvement in efficiency? Does the lack of improvement in fact indicate that its efficiency has been deteriorating rather than improving? This may be the case, but once again, some caution is required in interpretation of DEA results. DEA gives us an efficiency frontier, and it may be that the relatively high efficiency reported in the early part of the period for the BNZ (and which is evident in Tables 2 and 3) is merely an indication that the bank is close to a different point on the efficiency frontier compared to its position during the latter part of the period studied.[14]

(6) Conclusion

This paper has taken a different approach to that which is usually followed in using DEA for examination of bank efficiency, and has looked at it on a time-series, rather than cross-sectional basis. As such it is the first stage in a larger research programme, which will later look at efficiency in cross-sectional terms, and which will also seek to

[13] In the case of ASB, it might be that the efficiency score for June 1996 was generated by random error (a recognised problem with DEA – see above), resulting in the extent of efficiency improvement being understated. We have rerun the model with this case omitted, but note that changes to remaining efficiency scores are minor, although the R^2 values for the regressions under Model 1A and 1B increase to 19.5% and 33.1% respectively (although the coefficients obtained for other than the constant are still not significant).

[14] Interestingly, in results reported in Su and Tripe (2001), Table 6, BNZ does not show as being on the efficiency frontier after 1996. In neither Table 6 nor 7 does ASB show as being on the efficiency frontier after 1995.

try and understand more about the alleged greater efficiencies that New Zealand bank have been achieving.

Major findings from the first stage of this study are therefore as follows. New Zealand banks have become more efficient, in general, over the period 1996 to 2001, although a part of the improvement in efficiency appears to be a consequence of the fall in the general level of interest rates. If we look collectively at the banks which dominate the retail banking sector, around 60% of the improvement in efficiency can be accounted for by falls in interest rates.[15] The rest of the improvement in efficiency may be able to be accounted for either by improved managerial practice in improving X-efficiencies, or by technical progress which has allowed banks to improve their efficiency (reflected in a movement in the efficient frontier). If we look at the collective figures again, we find that time trend appears to account for a further approximately 30% of the observed efficiency improvements (noting that time could ever only be a relatively crude proxy for technical progress or for the effects of managerial effort to be realised).[16]

We have also found, however, that there are significant differences between the results reported by different DEA models, and that the way in which inputs and outputs are specified can have a major impact on the results reported. One of the pieces of research to follow from this, therefore, is to explore a rather wider range of models, to see if there are other specifications which may be less susceptible to distortion by the choice of variable. This may also allow us to gain a better understanding of the extent of efficiency improvements actually achieved by New Zealand banks.

We have also come to question the possibility that some banks may not be achieving efficiency improvements, despite the emphasis on efficiency improvement being promoted by bank managements. It will be interesting to look for ways in which this can be explored further, perhaps by extending the time period studied. The apparent variation in individual bank efficiency through time suggests that an underpinning of

[15] This figure is based on the average R^2 from the two models used.
[16] Moreover, as Walker (1999) notes, time trend may catch a number of other factors, even if his example of banking regulation is not obviously an issue in this case.

the one of the parametric approaches to frontier analysis, DFA, might not hold (Berger, 1993).

It would also be interesting to explore efficiency trends in other countries, particularly those with relatively concentrated banking markets, and where there has also been an emphasis on improving efficiency, such as Australia. A limitation here, however, would be that research might be restricted to annual data. Another technique being used to explore productivity changes over time is the Malmquist index (Fukuyama, 1995; Worthington, 1998; Alam 2001), and these might also provide a basis for further analysis. It will also be interesting to try and compare the performance of banks against each other, and to attempt some cross-country comparisons, particularly for the same banks operating in both Australia and New Zealand.

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Table 1: Approaches followed in previous Australasian DEA analysis

Source	Inputs	Outputs
Avkiran (1999) Model A	Interest expense Non-interest expense	Net interest income Non-interest income
Avkiran (1999) Model B	Deposits Staff numbers	Net loans Non-interest income
Sathye (2001)	Labour Capital Loanable funds	Loans Demand deposits
Su & Tripe (2001) Model A	Interest expense Non-interest expense	Net interest income Non-interest income
Su & Tripe (2001) Model B	Interest expense Non-interest expense	Customer deposits Net loans and advances Operating income
Su & Tripe (2001) Model C	Interest expense Non-interest expense	Deposits Loans and advances Operating income

Table 2: Model 1 results (percentage efficiencies).

Quarter ended	ANZ	ASB	BNZ	Citibank	HSBC	NBNZ	TSB	WestpacTrust
June 1996	86.78	100.00	99.74	96.34	93.2	81.5	92.07	90.65
September 1996	88.23	91.38	94.46	99.66	100	81.6	88.55	87.98
December 1996	84.24	97.90	98.71	90.3	93.42	83.31	91.17	97.35
March 1997	88.58	98.20	100	96.48	98.15	88.12	83.23	94.75
June 1997	88.54	93.57	100	N/A	96.74	88.73	90.33	93.24
September 1997	96.77	92.07	96.41	89.25	94.84	88.04	89.19	94.49
December 1997	N/A	94.21	99.49	88.15	95.5	88.45	90.26	95.32
March 1998	89.42	100.00	96.96	92.27	94.12	88.88	88.99	91.56
June 1998	87.81	98.13	100	91.18	100	88.94	92.3	100
September 1998	98.62	96.23	94	100	97.79	89.06	95.35	99.92
December 1998	94.14	95.40	97.3	N/A	98.33	92.28	100	94.43
March 1999	99.59	100.00	95.67	91.3	100	100	93.98	100
June 1999	100	100.00	100	100	100	100	100	98.35
September 1999	100	98.79	92.36	93.87	100	100	99.05	100
December 1999	99.16	100.00	99.14	100	100	98.14	100	100
March 2000	97.43	100.00	100	94.11	99.17	100	98.08	99.17
June 2000	95.54	96.92	99.75	97.65	100	100	100	99.37
September 2000	90.11	96.88	100	100	100	97.48	100	100
December 2000	96.71	100.00	100	100	98.03	94.69	99.7	99.17
March 2001	100	99.00	100	100	96.81	99.31	91.04	98.14
June 2001	100	100.00	99.22	100	99.2	100	100	99.78

Table 3: Model 2 results (percentage efficiencies).

Quarter ended	ANZ	ASB	BNZ	Citibank	HSBC	NBNZ	TSB	WestpacTrust
June 1996	77.45	100	98.91	84.22	45.07	62.7	86.11	69.74
September 1996	76.53	76.63	84.06	98.55	74.96	68.64	75.87	64.19
December 1996	75.76	96.76	96.17	44.56	57.12	76.03	79.62	72.95
March 1997	88.58	97.22	100	85.43	87.41	71.38	64.83	75.91
June 1997	88.13	85.81	100	N/A	80.25	72.78	88.79	80.62
September 1997	96.77	85.83	89.83	53.7	71.54	68.01	76.78	84.61
December 1997	N/A	89.28	98.39	84.62	72.91	68.59	79.51	85.89
March 1998	72.34	90.53	90.05	66.31	71.09	69.59	75.92	83.32
June 1998	76.54	83.7	99.14	57.72	82.68	69.58	86.37	91.14
September 1998	97.96	89.51	81.97	100	86.31	71.53	94.33	96.47
December 1998	87.29	90.76	93.88	N/A	90.24	79.86	100	88.73
March 1999	98.51	100	99.04	53.93	100	100	92.03	100
June 1999	100	100	100	100	100	100	100	96.95
September 1999	100	97.28	86.41	65.78	100	100	98.76	100
December 1999	98.94	100	99.09	100	100	95.26	100	100
March 2000	96.79	100	100	92.25	94.77	100	96.09	99.17
June 2000	94.18	94.32	99.67	85.96	100	100	100	98.95
September 2000	84.75	94.33	100	100	100	92.88	100	100
December 2000	96.37	98.55	100	94.56	88.09	91.06	98.87	95.81
March 2001	100	95.44	100	100	93.35	97.57	80.86	94.42
June 2001	100	100	97.81	N/A	95.09	100	99.86	99.01

Table 4: Correlation coefficients for efficiency scores relative to time trend (in quarters) for each model.

Bank	Model 1	Model 2
ANZ	.717	.667
ASB	.472	.478
BNZ	.197	.307
Citibank	.501	.421
HSBC	.543	.779
NBNZ	.894	.853
TSB	.738	.687
WestpacTrust	.741	.875

Table 5: Regression results for individual bank efficiency

Model	ANZ	ASB	BNZ	Citibank	HSBC	NBNZ	TSB	Westpac Trust
1A	62.8%	12.8%	0.7%	7.2%	32.1%	71.1%	45.3%	39.9%
Constant	111.539 (34.26)**	101.612 (40.63)**	97.419 (42.90)**	100.662 (23.27)**	103.367 (54.86)**	115.538 (33.74)**	108.620 (29.56)**	106.225 (39.10)**
Interest rate	-2.5332 (-5.52)**	-.5825 (-1.67)	.1190 (0.38)	-.6862 (-1.15)	-.7892 (-3.00)**	-3.2673 (-6.83)**	-2.0360 (-3.97)**	-1.3475 (-3.55)**
1B	69.8%	22.6%	12.3%	26.2%	37.1%	91.0%	60.5%	58.5%
Constant	103.17 (19.90)**	96.383 (22.85)**	92.604 (24.22)**	88.724 (12.49)**	100.190 (30.85)**	97.842 (28.64)**	96.569 (17.27)**	96.828 (23.93)**
Interest rate	-1.8086 (-3.22)**	-.1287 (-0.28)	.5369 (1.31)	.3570 (0.47)	-.5135 (-1.48)	-1.7315 (-4.73)**	-.9902 (-1.65)	-.5321 (-1.23)
Time trend	.3215 (1.98)	.1881 (1.51)	.1732 (1.54)	.4576 (2.03)	.11429 (1.19)	.6366 (6.32)**	.4335 (2.63)*	.3380 (2.84)*
1C	N/A	N/A	N/A	28.9%	42.8%	N/A	N/A	N/A
Constant				92.487 (10.59)**	95.669 (20.22)**			
Interest rate				0.6181 (0.74)	-.8676 (-1.98)			
Time trend				0.7009 (1.78)	-.0047 (-.04)			
Total Assets				-.004292 (-0.76)	.001865 (1.29)			
2A	61.3%	30.5%	3.8%	3.9%	66.4%	62.7%	47.5%	61.3%
Constant	121.404 (20.29)**	108.478 (20.48)**	100.563 (18.26)**	97.33 (4.83)**	136.134 (15.95)**	129.813 (15.45)**	119.671 (15.87)**	125.333 (18.61)**
Interest rate	-4.5075 (-5.34)**	-2.1342 (-2.88)**	-.6660 (-0.87)	-2.217 (-0.80)	-7.303 (-6.13)**	-6.638 (-5.66)**	-4.366 (-4.15)**	-5.1570 (-5.48)**
2B	65.6%	32.7%	9.5%	19.1%	76.6%	81.9%	56.9%	83.8%
Constant	109.612 (10.99)**	102.573 (10.99)**	92.238 (9.64)**	50.24 (1.48)	106.90 (8.37)**	92.29 (8.80)**	99.79 (8.16)**	93.344 (11.97)**
Interest rate	-3.487 (-3.23)**	-1.6217 (-1.62)	0.056 (0.06)	1.839 (0.52)	-4.766 (-3.49)**	-3.381 (-3.01)**	-2.641 (-2.02)	-2.3809 (-2.85)*
Time trend	0.4530 (1.45)	.2124 (0.77)	.2994 (1.06)	1.915 (1.68)	1.0516 (2.80)*	1.3498 (4.37)**	.7150 (1.98)	1.1507 (5.01)**
2C	N/A	N/A	N/A	20.2%	79.0%	N/A	N/A	N/A
Constant				61.06 (1.43)	87.80 (4.76)**			
Interest rate				2.521 (0.63)	-6.263 (-3.67)**			
Time trend				2.551 (1.36)	.5486 (1.07)			
Total Assets				-.01178 (-0.43)	.007880 (1.40)			

** indicates significance at the 1% level

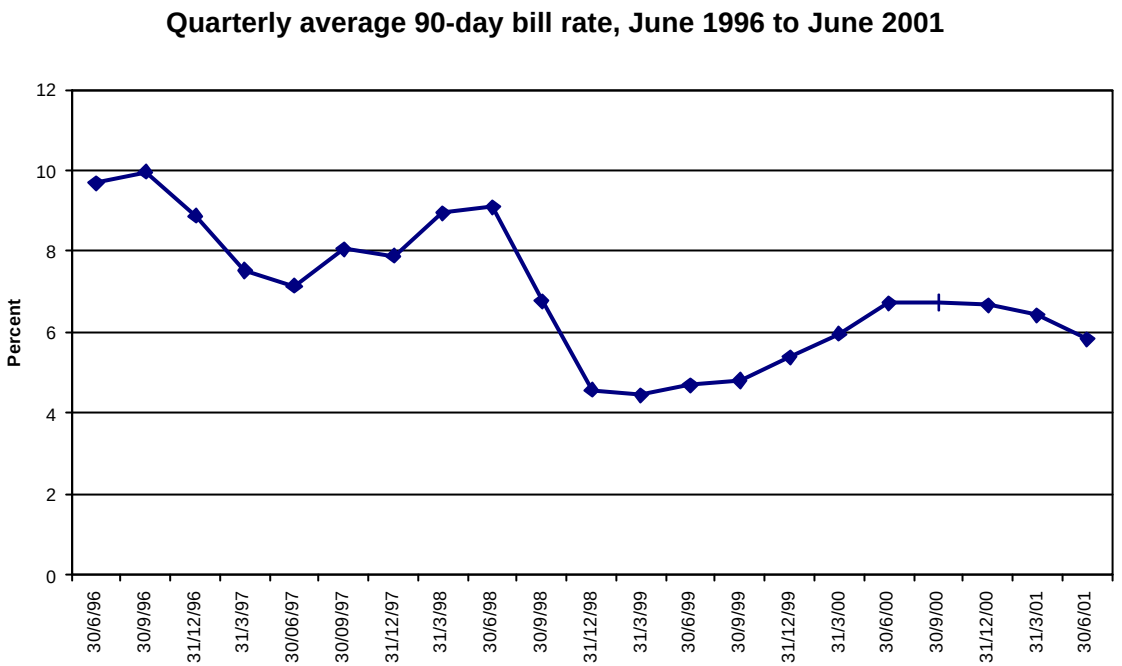
* indicates significance at the 5% level.

Table 6: Regression results for efficiency of all retail banks (treated as a single entity).

	Model 1	Model 2
Regression A – R^2	55.9%	63.9%
Constant	108.373 (40.25)**	124.328 (19.55)**
Interest rate	-1.8354 (-4.78)**	-5.1188 (-5.64)**
Regression B – R^2	85.5%	92.2%
Constant	96.467 (37.45)**	93.923 (19.03)**
Interest rate	-.8054 (-2.81)*	-2.4886 (-4.52)**
Time trend	.46425 (5.88)**	1.1856 (7.83)**

** indicates significance at the 1% level
* indicates significance at the 5% level.
Regression C (with total assets as an explanatory variable) is not reported, as the regression was invalidated by multicollinearity (correlation between time trend and total assets).

Chart 1



Data are an average of the monthly figures reported by the Reserve Bank of New Zealand (as per their web-site).

Chart 2