Using DEA to investigate bank safety and soundness – which approach works best?

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Abstract:

This paper investigates the use of different Data Envelopment Analysis (DEA) models to explore the relationship between changes in profitability and changes in efficiency of New Zealand banks that undertake retail business, where bank performance is studied as part of a process of assessing bank safety and soundness. A type of intermediation approach is used, with the types of DEA models used being the classic CCR model, a profit efficiency model, and a non-oriented slacks-based approach.

The most useful results for understanding bank performance are generated from the slacks-based approach.

JEL Codes:

G21, D24.

Keywords:

Banking, Efficiency, Data Envelopment Analysis (DEA), New Zealand, Prudential supervision.

(1) Introduction

Studies of bank and financial institution efficiency have been undertaken for a variety of purposes. Efficiency in financial institutions is and should be a matter of public concern, as not only can more efficient financial institutions be expected to be more profitable, but one should also expect financial institution efficiency to lead to greater amounts of funds being intermediated, and better service at lower prices for consumers. Other things being equal, more efficient financial institutions should exhibit greater safety and soundness (Berger et al., 1993, pp 221-222), while also showing better credit quality in the loan portfolio (Berger & DeYoung, 1997). These issues also provide a basis for looking at the efficiency implications of both bank mergers and acquisitions and government policy initiatives.

This study focuses on bank safety and soundness, which has been of particular importance in the New Zealand context because, prior to October 2008, there was no general deposit protection scheme for bank customers. This meant that the onus of assessing the soundness of the banks with which they dealt fell upon the banks' customers: banks are required to make disclosures to the public on a quarterly basis, and it is this information which is also provided to the Reserve Bank of New Zealand as the prudential supervisor of the banking system. The principle has been that if the Reserve Bank had no better information than was made available to the general public, it could not be liable to recompense depositors if a bank failed.[1]

Banks' quarterly disclosures include a year-to-date income statement and balance sheet, which allow an analyst to construct a quarterly income statement, and thus make a detailed assessment of financial performance. Such an assessment of financial performance is likely to focus on key risk factors, and thus credit risk will be assessed by levels of impaired and past due loans and bad and doubtful debt expense, interest rate risk by the level and volatility in a bank's net interest income, operational risk by the bank's non-interest expense, and solvency by the ratio of capital to assets and the flow of profits to sustain that capital level. Relevant accounting ratios have been compared between banks, and through time, in an effort to understand profitability change from quarter to quarter, and to monitor exceptional items which might give grounds for concern.

[1] The introduction of a deposit protection scheme on 12 October 2008 has not undermined this principle for wholesale deposits, and banks continue to provide quarterly disclosures to the market. For more detail on the disclosure regime, see Mortlock (1996).

Grifell-Tatjé & Lovell (1999) noted that a change in a firm's profits may derive from a number of sources, including a change in input or output prices. The other sources of profit change are likely to be measured using the techniques of efficiency analysis, including technical change leading to an increase in output without any increase in resource utilisation, an improvement or decline in operating efficiency (X-efficiency), or a change in output proportionately greater or less than input utilisation, reflecting economies or diseconomies of scale. Further sources of profitability improvement include changes in product or resource mix, associated with economies of scope and allocative efficiency.[2] Against this background, it is considered appropriate to use the methods of efficiency analysis to study the profit performance of New Zealand banks from quarter to quarter, as part of the process of assessing their safety and soundness. Efficiency analysis allows us to explore trade-offs between the different inputs and outputs used, something which is inherently problematic if one is constrained to use of ratios (Golany & Storbeck, 1999).

The rest of the paper proceeds as follows. In the next section we outline the approach that will be followed against the background of the key literature that is relevant to this research. In section 3 we look at the New Zealand banking system, and the data that are generated from the disclosures to permit this research. Section 4 reports results that are obtained, while section 5 provides a summary and conclusion.

(2) The method for this research, and relevant prior research on bank efficiency

Berger & Humphrey (1997) reported on 130 studies of bank efficiency, and a great many more articles have been published since that review. These studies have used both parametric methods – stochastic frontier analysis (SFA), the distribution free approach (DFA) and the thick frontier approach (TFA) – and non-parametric methods – data envelopment analysis (DEA) and the free disposal hull (FDH). The key differences between the approaches are that the non-parametric methods do not take account of random error in observations, while the parametric approaches require specification of a functional form. The complexity and diversity of production relations in banking mean that the specification of the functional form is not self-evident: the imposition of an inappropriate functional form can effectively distort the findings of any analysis.

[2] See also Lovell (2008).

This study uses DEA, a number of forms of which have been developed since the original constant returns to scale (CCR) model was developed by Charnes et al (1978). Banker et al (1984) introduced a variable returns to scale (BCC) model, use of which allows exploration of scale economies. Further subsequent variants include the cost, revenue and profit models, which take account of input and output prices, and which can thus provide estimates of allocative efficiency.[3] More recently again we have seen the introduction of slacks-based models (Tone, 2001), which identify a broader range of inefficiencies through consideration of non-radial slacks.[4]

Another distinction between DEA and the parametric approaches is in the focus on the individual decision making unit (DMU - bank in this case). DEA both generates individual efficiency scores for each bank for each time period, and identifies which inputs have been over-utilised and/or outputs underutilised to engender that inefficiency. Of the parametric approaches, only SFA provides an observation-specific efficiency score, but even then DEA identifies a peer group of more efficient units against which an individual unit's efficiency can be compared. Because we are looking to understand the factors behind differences in individual bank profitability, DEA is a more appropriate method for this study.

Another factor that sometimes influences the choice between DEA and one of the parametric approaches is the number of DMUs to be included in the analysis. Parametric methods generally require larger data sets, not so much in that DEA is better with a smaller data set, but rather because the greater flexibility of DEA does not preclude its use for smaller data sets. In this case, with a cross-section of no more than 6 comparable banks for the period studied, DEA would be a necessity. Even here, though, we need a greater number of observations to allow meaningful differences in efficiency to be observed: we achieve this by studying our cross-section of banks over consecutive time periods, in a panel. We would wish to analyse the data set as a panel in any case, however, because to understand profitability changes, we need to be looking at previous accounting periods alongside the most recent ones.

The standard approach to looking at efficiency change between two different periods is by use of the Malmquist index, which allows a decomposition of productivity change into the effects of technological change and change in efficiency. This is not what we are looking for in this study, where we expect profitability change to be impacted more by changes in prices and quantities, and

[3] DEA has been criticised previously for only providing measures of technical efficiency. See, for example, Berger & Mester (1997).
[4] For a more detailed exposition of DEA methodologies, see Cooper et al (2000) or Avkiran (2006).

in the efficiency with which inputs are used and outputs created. We are also looking at a relatively short time period, which means that the effects of any technological change that might invalidate the use of panel data would not be expected to be major.[5]

Another key issue in studying the efficiency of financial institutions is in selecting a model of the banking firm. The two main methods are the production and intermediation approaches, although the production approach is more often used for measurement of the efficiency of individual branches, rather than for banks as a whole. The intermediation approach exists in a number of different forms, but it is essentially based on the process of converting depositors' funds into loans, and it is the predominant method for studying banks as a whole. The approach we use in this study is broadly consistent with the intermediation approach.

Dyson et al (2001) remind us that the important point in selecting inputs and outputs for DEA studies (and, by implication, other efficiency studies as well) is that we should be looking for input variables which include as much as possible of the resources that DMUs use. In turn, we should be looking at output variables which include as much as possible of the relevant outputs, but which also identify the key success factors for the entities whose efficiency is being studied.

Relevant inputs and outputs can thus be identified from looking at the way banks generate profits. They incur interest expense, and use non-interest expense and shareholders' equity to generate interest and non-interest income. A side effect of this production process is bad and doubtful debt expense, which reduces profitability, and which might thus be regarded as a negative output (and which can thus be processed within DEA as an input).[6] The interest income and expense can be decomposed into prices (interest rates) and quantities, although such a decomposition cannot meaningfully be conducted for the other inputs and outputs used.

Use of shareholders' equity as an input is not universal in the prior literature, but it can be justified. In the first place, shareholders' equity is a source of funding, and if a bank has more equity, it should need less funding, while the higher proportion of equity should reduce the cost of those funds. More importantly, however, as discussed by Berger & Mester (1997), equity gives a bank a greater cushion

[5] This is consistent with the approach outlined by Tulkens & Vanden Eeckaut (1995). In practice, no indication was found in the results from this research that there was any general change in banks' efficiency through time.

[6] Reflecting concerns about banks' use of bad and doubtful debt expense to smooth profits, we also tried use of total impaired and past due assets as an alternative input.

against risk, which allows it to increase the size of its loan portfolio (which might also otherwise be constrained by capital regulation).

This contrasts with our decision to omit physical capital or staff as inputs, with prior researchers often having calculated prices for these based on relevant expenditure. In our view, a major problem with attempting to include physical capital is that, in many cases, items of physical capital will be leased rather than owned. Even if they were owned, there might be problems with their valuation.[7] In practical terms, neither the costs associated with physical capital or staff costs are consistently disclosed quarterly, and as staff numbers are not reported either, neither of these measures which have commonly been used in previous research are available to us. We are therefore obliged to use aggregate non-interest expense as an input.

Having identified the method that should be used for his research, we now look at the New Zealand banking system and the data that it provides for our study. In the course of our discussion we will also address some further methodological issues.

(3) New Zealand banking data

We noted in the introduction that New Zealand lacked any formal deposit protection scheme (prior to October 2008), and that supervision of the banking system was based on public disclosure. The key elements of this are the quarterly disclosure statements, which include year-to-date financial statements. Even if this were not the basis for the prudential supervision of the banks, the disclosure statements are a boon for researchers in terms of the data they provide.

One of the reasons why this approach to banking supervision is viable in New Zealand is that the number of banks undertaking retail business is relatively small. As at 31 March 2008, the four largest banks accounted for 89.4% of total banking system assets. Two further smaller banks that also emphasized retail business accounted for a further 2.9% of banking system assets.[8]

A further consideration in the Reserve Bank of New Zealand's lighter approach to banking supervision is the extent of foreign ownership of the banks, with more than 97% of bank assets

[7] Beyond that, physical capital is more-or-less insignificant as an input for New Zealand banks, with fixed assets comprising an average of 0.2% of assets.
[8] There were a total of 18 registered banks as at 31 December 2008.

under foreign ownership at 31 March 2008. The four major banks, ANZ National Bank (ANZ, owned by the ANZ Banking Group Limited), ASB Bank (ASB, owned by the Commonwealth Bank of Australia), Bank of New Zealand (BNZ, owned by the National Australia Bank), and the Westpac Banking Corporation (Westpac) are all Australian-owned, with their parents all among the 10 largest companies on the Australian Stock Exchange. The New Zealand-owned banks are Kiwibank (government-owned through New Zealand Post) and TSB Bank (TSB, owned by a local community trust), which have a combined market share of 2.9%.

Our sample frame for this study thus comprises 6 banks, the four Australian-owned majors and the two New Zealand-owned banks, which together dominate retail banking. A limited amount of retail banking is provided by the New Zealand branches of HSBC and (Korean-owned) Kookmin Bank, but these two entities show balance sheets and income statements which are quite different from those included in the study – it is argued that the necessary condition of relative homogeneity to allow reasonable comparisons would not apply to these banks. Rabo New Zealand Limited is also omitted from the study: although it is New Zealand incorporated, it specialises in lending to the rural sector and would appear to rely to at least some extent on the Rabobank Nederland New Zealand branch for its functioning.

During the period covered by this study, the Commonwealth Bank of Australia (CBA) and Westpac each had two registered banks operating in the New Zealand market. In the CBA's case, the overwhelming majority of its business is in its subsidiary, ASB, with this apparently capable of surviving independently (which it did for a long time up to its parent's registration of a branch). In the Westpac case, however, the New Zealand subsidiary was established primarily to comply with New Zealand regulatory requirements, and it is doubtful that it could survive in its own right. Moreover, its relatively recent establishment (in late 2006) means that it is not clear that it yet has a stable pattern of operations. For both of these reasons we have chosen to use the Westpac branch in the study, rather than the subsidiary.

The initial analysis in this study covers the period from the December quarter 2005 through to the March quarter 2008 – 10 quarters for 6 banks, giving us 60 observations in total, which should be ample relative to the combined total of 6 inputs and outputs. A key factor in the choice of start date was the adoption of international financial reporting standards (IFRS) by the major Australian banks (and thus for their New Zealand operations as well), for their financial years ending in 2006. IFRS will have had a particular effect on bad and doubtful debt expense (in terms of removing banks'

discretion to record additional provisions without objective evidence of impairment), on interest income and expense where fees and costs have to be amortised over the life of the assets and liabilities to which they apply, and because of the way derivative assets and liabilities have to be accounted for, with the revaluations impacting particularly on non-interest income.[9] Following the adoption of IFRS, less of the variability in profitability ought to be able to be attributed to variation in accounting practices.[10]

Data were checked using a slacks-based super-efficiency model (Tone, 2002) and no cases were identified which suggested any problems.[11] A review of the correlations between the inputs, the outputs and between the inputs and outputs also failed to identify any concerns in respect of the data being used for the study.

A minor adjustment was required to the data for bad and doubtful debt expense, to remove negative values and replace these with zeros. This was because the negative values artificially shifted the frontier to the extent that a negative efficiency scores were generated for one DMU in the slacks-based model. Negative values for bad and doubtful debt expense would indicate an impact of recoveries of write-offs from earlier accounting periods: there is thus an argument that a value of zero would more fairly reflect current performance. Significant changes in efficiency scores were generated only for one DMU, which continued to show significant inefficiency (but no longer a negative score).

As a further preliminary check on our data, recognizing the range of bank size from NZ$ 3 billion[12] for TSB up to NZ$ 100 billion for ANZ, we checked for scale effects. The strongest indications of scale inefficiency were found for ANZ, with mean scale efficiency of 0.96, but which was nonetheless shown as being fully scale efficient in one quarter. Noting the tendency of observations of different size to show as scale inefficient because of the relative dearth of other observations in that size bracket (Dyson et al, 2001), which would be the case for ANZ, we have preferred to use constant returns to scale models so as to increase the models' sensitivity (by reporting numerically lower efficiency scores). Moreover, having regard to the objectives of our study, we note that we want to

[9] TSB and Kiwibank were not required to adopt IFRS until the financial years commencing in 2007, but the simpler nature of their operations means that the change in accounting standards has had less impact on results.
[10] This thus mitigates the potential problem of random error in the use of DEA.
[11] The highest super-efficiency score was 1.25, well below the guideline level of concern of 2 – see Hartman et al (2001).
[12] One New Zealand dollar is equivalent to approximately 60 cents US.

identify sources of inefficiency regardless of their cause: if they are scale related, they are still important for identifying issues of banks' safety and soundness.

(4) Results

The three models around which this analysis is undertaken are a basic CCR model, a profit efficiency model (to look at the effects of decomposing monetary amounts and the interest rates applying to them), and a slacks-based model (where we are expecting the greatest inefficiencies). We will deal with each of these in turn, with a particular focus on the observations for the March 2008 quarter, in terms of understanding the changes in profitability. These can be highlighted by looking at the changes in banks' return on assets (ROA) in the March 2008 quarter relative to the previous, December 2007 quarter, as demonstrated in Figure 1.

[Insert Figure 1 about here].

Table 1 shows us the efficiency scores for each bank for each quarter, from the CCR model.

[Insert Table 1 about here].

The differences between profits (as measured by ROA) and the efficiency scores are striking, but we also note that the range of efficiency scores in the CCR model is not great, with a mean efficiency score across all 60 DMUs of 0.979. We can select a couple of cases for more detailed examination: let us look at BNZ, which showed an improvement in profitability but a deterioration in efficiency, and at Kiwibank, which showed an improvement in efficiency but a deterioration in profitability, in the final quarter of the study.

In the BNZ's case, we find that it showed an increase in bad and doubtful debt expense in the March 2008 quarter, and although this may not have had a big impact on profitability, it has had a significant impact on efficiency. For the study of bank safety and soundness, this is a useful warning flag.

In Kiwibank's case, we find evidence for excess non-interest expense in particular in the December 2007 quarter, but the relationship is not strong. Part of the problem would appear that, for the CCR model, we are using an input-oriented model, and although this is logical for studies of banks as a

whole (where they can change their inputs but not the aggregate volume of their outputs, which are determined by the market), it is not especially helpful for understanding profitability change (where profitability is determined by both inputs and outputs).[13]

Table 2 shows us the efficiency scores from the profit efficiency model.

[Insert Table 2 about here].

Efficiency scores are now significantly lower on aggregate, with a mean efficiency score across all DMUs of 0.943, which means that this model is more appropriately identifying inefficiencies. This reflects the aspects of the profit model, that it combines allocative and technical efficiency, that it identifies both cost and revenue inefficiencies (and the reported profit inefficiency thus allows for both of these), and that it is not oriented (in the way that the CCR model is). This is consistent with the definition of profit efficiency as

$$Ep = \frac{p_o y_o - c_o x_o}{p_o y^* - c_o x^*}$$

where x^* and y^* represent the vectors of the optimal quantities of inputs and outputs, x_0 and y_0 are the vectors of the observed quantities of the inputs and outputs, and p_0 and c_0 the prices (Cooper et al, 2000).[14]

If we look at the BNZ, we find that the major driver for (the now much more pronounced) inefficiency in the December 2007 and March 2008 quarters is bad and doubtful debt expense. This contrasts with the simple ratios, where BNZ shows as having lower levels of bad and doubtful debt expense than either ANZ or Westpac,[15] but the outcomes observed are a consequence of looking at all the inputs and outputs together, on a multivariate basis. BNZ also shows some inefficiency as deriving from interest revenues, with insufficient interest bearing assets (and this is despite what appears to be a relatively good net interest income performance in this quarter and the previous ones).

ANZ's inefficiency also derives from bad and doubtful debt expense, but also from an overuse of equity (reflecting its need to hold a significantly larger quantity of equity because of the goodwill on

[13] In fact, for a CCR model, the results from input-oriented or output-oriented model will be identical.
[14] See also Paradi (2006).
[15] Detailed data are omitted for reasons of space and readability, but are available from the author on request.

its balance sheet from the surplus over book value paid when it acquired the National Bank of New Zealand in 2003). These two factors account for most of the ANZ's inefficiency throughout the period studied.

TSB's inefficiency in the March 2008 quarter derives from higher levels of bad and doubtful debt expense (which appears to reflect a standard adjustment in the March quarter, which is the final quarter of its financial year), and a deficiency in non-interest income (which TSB generally earns less of in any case).

Kiwibank's inefficiency appears to be caused by higher levels of non-interest expense, and, to a much lesser extent, from higher levels of interest expense. Kiwibank's non-interest expenses have been consistently greater than for other banks, but the much stronger identification of inefficiency in this case may be a consequence of revenues being lower than in previous quarters. What we are finding overall is that the profit model is giving us more useful results than the CCR model, in terms of understanding differences in profitability from quarter to quarter, with a stronger relationship between profitability change and efficiency change.

The slacks-based model (which was run on a non-oriented basis) shows significantly greater levels of inefficiency, with a mean efficiency score across all DMUs of 0.797. A major reason for the lower scores is that the slacks-based model also takes account of non-radial slacks.[16]

[Insert Table 3 about here].

ANZ now shows as being particularly inefficient in all but one of the 10 quarters in our analysis. The major contributors to this are excessive levels of equity and higher levels of bad and doubtful debt expense, as previously discussed in respect of the profit efficiency model.

ASB once again shows as relatively efficient, which is interesting in view of its much lower level of gross income (defined as net interest income plus non-interest income), as shown in Figure 2. The relatively high efficiency reflects the relatively low usage of resources to generate that gross income. Where ASB was inefficient, it appears that this could be mainly attributed to bad and doubtful debt expense, with some shortages of non-interest income.

[16] There was no slacks-based profit model available in the version of the DEA-Solver software (5.0) used for this research.

[Insert Figure 2 about here].

BNZ's inefficiency in the March 2008 quarter appears to be largely attributable to excess bad and doubtful debt expense, although it also shows as using excess equity and interest expense, and as generating insufficient non-interest income. Although Westpac showed as fully efficient in the March 2008 quarter, its inefficiency in previous quarters appears to be able to be attributed mainly to excess interest expense and bad and doubtful debt expense.

TSB showed a dramatic drop in efficiency in the March 2008 quarter. The major contributor to its inefficiency is low levels of non-interest income, with lesser impacts from high levels of bad and doubtful debt expense and equity. This would not be too much of a surprise to analysts who have studied the bank's ratios: the bank is rather more strongly capitalised than others, largely to compensate for its small size and lack of access to external capital, while the nature of its business means that its non-interest income should be expected to be low.

Kiwibank also shows as relatively efficient overall, which is likely to reflect its higher levels of gross income, as evident in Figure 2. Once again, where there was significant inefficiency, this appeared to relate mainly to higher levels of bad and doubtful debt expense (even though bad and doubtful debt expense for Kiwibank, like TSB, has been low). We note, however, that inefficient Kiwibank DMUs show only Kiwibank in their reference sets, while Kiwibank only plays a very small part in the reference sets for their inefficient DMUs. There is thus a question as to whether Kiwibank shares a common frontier with the other banks in the study.

If we look at the inefficiencies across the data set as a whole, we find that bad and doubtful debt expense is the most prevalent. This is likely to reflect its variability in terms of its contribution to bank profitability, and the fact that the absolute values of the numbers are sometimes very low, which means that the relative change in bad and doubtful debt expense can be very large. It can be expected to be more significant in its impact on profits in coming quarters, with higher levels of bad and doubtful debt expense associated with the economic downturn. Our results may also be a consequence of bad and doubtful debt expense being a negative output, which we are treating as in input, and it is therefore considered appropriate to re-run the analysis with this variable omitted. The economic meaning for this model would be to relate to banks' underlying profitability (i.e profit before bad and doubtful debt expense, extraordinary items or tax), which also reflects the fact that bad and doubtful debt expense will generally relate to the bank's performance in quarters prior to

the one that is being studied. It is this underlying profitability which is going to be more important for a bank's long term profitability and soundness.

Results for the (non-oriented) slacks-based model, without bad and doubtful debts as an input, are reported in Table 4. The mean efficiency across all DMUs is 0.812, which is only marginally higher than for the previous model.

[Insert Table 4 about here].

If we look at individual banks, we find that ANZ shows as consistently relatively inefficient. The major contributor to this continues to be an excessive level of equity (as discussed previously), although the main subsidiary reason is now an insufficiency of non-interest income. ASB and BNZ also show, in most cases, a surplus of equity and a shortage of non-interest income, although there are a number of quarters where ASB shows a small excess of interest expense. ASB continues to show as fully efficient in the March quarter 2008.

Westpac also shows as fully efficient in the March 2008 quarter: for the earlier quarters in which it showed as less than fully efficient, the inefficiency can be related to excess equity and insufficient non-interest income. TSB's inefficiency derives from the same two factors, although the shortage of non-interest income is much more important in this case.

Kiwibank's inefficiency is different, with no shortage of non-interest income, except in the March 2008 quarter when it was much less than usual. In Kiwibank's case, the major sources of inefficiency are excess non-interest expense (ratio analysis shows much higher relative costs than for the other banks) and insufficient interest income.

(5) Summary and conclusion

This paper has sought to investigate the changes in profitability from quarter to quarter for New Zealand's banks with significant retail business, with a particular focus on the changes in profitability between the December quarter 2007 and the March quarter 2008. We tested three different DEA methodologies, and found that the slacks-based method was most useful, although there was also value in using the profit efficiency approach. The CCR model showed very little variation in efficiency

between the different banks, and thus was less effective at identifying the causes of profitability change.

There was no clear indication that scale mattered, although the largest bank, ANZ-National, showed as least efficient, and it is possible that some of this inefficiency may be a consequence of scale (although it is noted that the input that consistently related to the inefficiency was equity, which ought to show positive benefits from increased scale). ANZ is carrying extra equity, however, because of the (intangible) goodwill associated with the acquisition of the National Bank of New Zealand in 2003.

The success of the approach followed in this paper ought to be of assistance to analysts in assessing the safety and soundness of New Zealand's banks, a process which is of particular importance in the New Zealand market because of the historic lack of deposit insurance or other guarantees for depositors. It is not altogether clear that inclusion of bad and doubtful debts as a negative output (and thus as an input) is helpful but we should be able to make further assessments of this as we look at the results for later quarters when the global economic downturn has its effect in increasing individual banks' levels of bad and doubtful debt expense. There may be merit in looking for other ways of dealing with bad and doubtful debt expense as an undesirable output in our DEA models.[17] It will also be interesting to investigate the use of new DEA models as these become available.

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[17] See the discussion by Burley (2006).

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Figure 1: Comparison of banks' return on assets (defined as net profit after tax divided by average total assets) between December quarter 2007 and March quarter 2008. Figures are annualized.

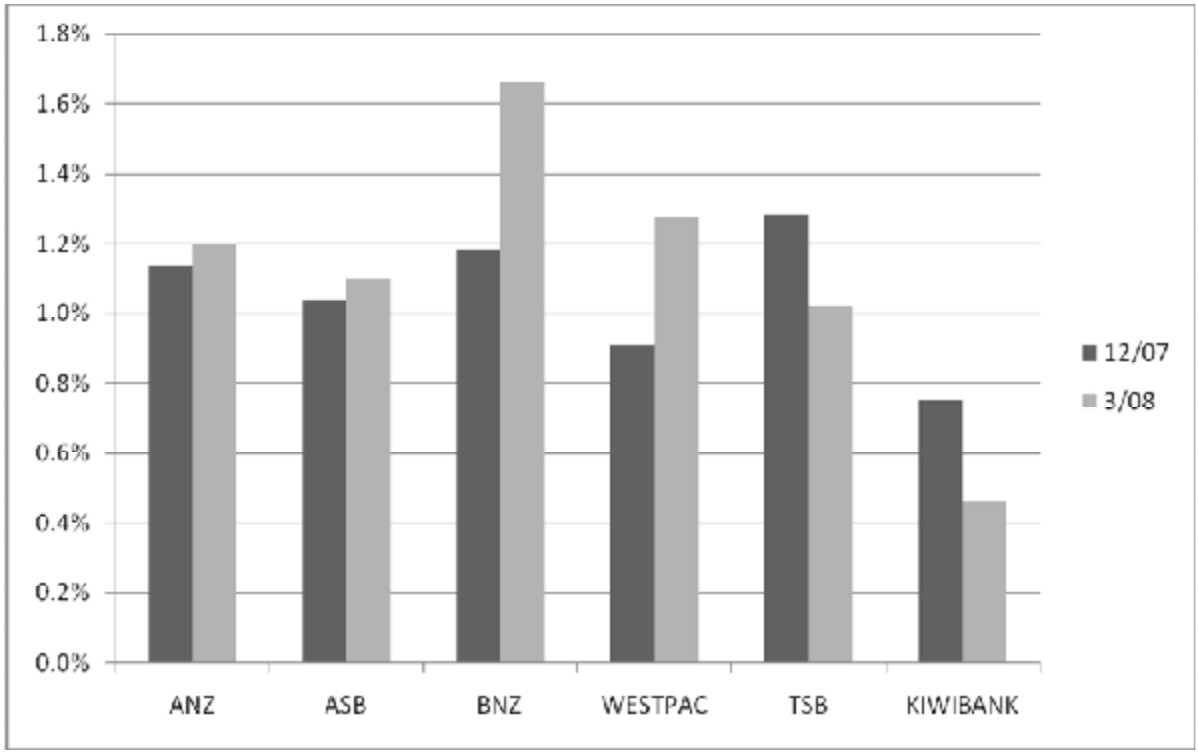

Figure 2: Comparison of banks' gross incomes (defined as net interest income plus non-interest income, divided by average total assets) between December quarter 2007 and March quarter 2008. Figures are annualized.

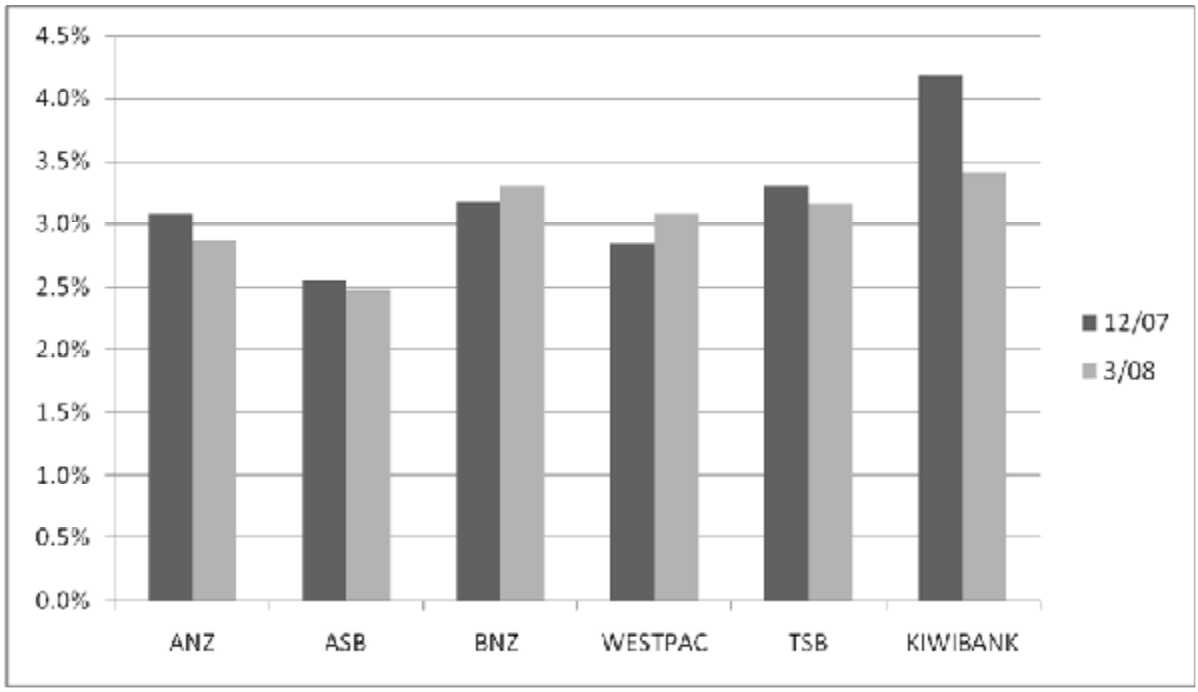

Table 1: Efficiency scores for each bank for each quarter, from the CCR model.

Quarter	ANZ	ASB	BNZ	Westpac	TSB	Kiwibank
Dec 05	0.988	0.967	0.958	1.000	1.000	1.000
March 06	0.931	0.962	0.954	1.000	1.000	1.000
June 06	1.000	0.981	1.000	0.975	0.987	0.976
Sept 06	0.966	0.974	0.961	0.984	0.991	1.000
Dec 06	0.939	1.000	1.000	0.976	0.985	0.981
March 07	0.978	1.000	0.948	0.981	0.973	1.000
June 07	0.929	0.997	0.990	0.981	1.000	1.000
Sept 07	0.967	0.982	0.964	0.958	1.000	1.000
Dec 07	0.959	1.000	0.972	0.950	0.973	0.962
March 08	0.979	1.000	0.944	1.000	0.960	1.000
Average	0.964	0.986	0.969	0.981	0.987	0.992

Table 2: Efficiency scores for each bank for each quarter, from the Profit efficiency model.

Quarter	ANZ	ASB	BNZ	Westpac	TSB	Kiwibank
Dec 05	1.000	0.928	0.862	1.000	0.998	1.000
March 06	0.888	0.890	0.810	1.000	0.982	1.000
June 06	1.000	0.926	1.000	0.947	0.987	0.961
Sept 06	0.856	0.994	0.907	0.936	0.896	1.000
Dec 06	0.876	1.000	1.000	0.917	0.990	0.930
March 07	0.933	1.000	0.857	0.972	0.983	1.000
June 07	0.912	1.000	0.973	0.949	1.000	0.764
Sept 07	0.895	0.940	0.883	0.944	1.000	1.000
Dec 07	0.971	1.000	0.832	0.889	1.000	0.887
March 08	0.893	1.000	0.838	1.000	0.963	0.800
Average	0.922	0.968	0.896	0.955	0.980	0.934

Table 3: Efficiency scores for each bank for each quarter, from the Slacks-based model.

Quarter	ANZ	ASB	BNZ	Westpac	TSB	Kiwibank
Dec 05	0.847	0.740	0.727	1.000	1.000	1.000
March 06	0.605	0.677	0.626	1.000	1.000	1.000
June 06	1.000	0.888	1.000	0.769	0.818	0.828
Sept 06	0.581	0.719	0.735	0.862	0.842	1.000
Dec 06	0.578	1.000	1.000	0.727	0.648	0.844
March 07	0.684	1.000	0.673	0.820	0.538	1.000
June 07	0.598	0.948	0.839	0.874	1.000	1.000
Sept 07	0.694	0.728	0.767	0.873	1.000	1.000
Dec 07	0.687	1.000	0.739	0.770	0.566	0.784
March 08	0.689	1.000	0.690	1.000	0.273	1.000
Average	0.696	0.870	0.780	0.870	0.769	0.946

Table 4: Efficiency scores for each bank for each quarter, from the Slacks-based model, without bad and doubtful debt expense as an input.

Quarter	ANZ	ASB	BNZ	Westpac	TSB	Kiwibank
Dec 05	0.723	0.723	0.847	1.000	1.000	1.000
March 06	0.700	0.674	0.678	1.000	1.000	0.967
June 06	0.631	0.721	1.000	0.887	0.867	0.939
Sept 06	0.708	0.657	0.843	0.890	0.889	0.928
Dec 06	0.665	0.739	1.000	0.826	0.744	0.929
March 07	0.710	1.000	0.781	0.869	0.663	1.000
June 07	0.636	0.799	0.850	0.798	1.000	0.815
Sept 07	0.681	0.630	0.777	0.797	1.000	0.905
Dec 07	0.684	0.775	0.711	0.719	0.581	0.877
March 08	0.693	1.000	0.735	1.000	0.342	0.702
Average	0.683	0.772	0.822	0.879	0.809	0.906