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ABSTRACT

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This study applies parametric distance functions to estimate the efficiency of foreign banks in Australia, and subsequently employs extreme bounds analysis to establish the determinants of foreign bank efficiency that are robust to model specification. The limited global advantage hypothesis of Berger et al (2000) is supported. Following clients is found to reduce the efficiency of the profit creation process. The market share of the incumbent banks acts as a barrier to entry to efficiency in the retail market, with acquisition of a domestic bank reducing this effect. Internet-based bank product delivery reduces the efficiency of profit creation in the initial phases of operation, and parent profits do not improve efficiency in the host market.

Keywords: Foreign bank efficiency, distance functions, extreme bounds analysis, barriers to entry, following clients

JEL: G15, G21, C15, C52

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1. Introduction

To date it has been largely found that foreign banks are less efficient than domestic banks (Berger *et al*, 2000). The central focus of this study is aimed at addressing the deeper question of "What factors determine differences in multinational bank efficiency?" In order to address this question, this study will apply parametric distance functions to Australian banking and thus also extend the previous work of Sturm and Williams (2004). Sturm and Williams (2004) found that foreign banks in Australia were more efficient than domestic banks, particularly due to superior scale efficiency. Given the previous results surveyed in Berger *et al* (2000), as well as the results of Sturm and Williams (2004), the Australian case provides a valuable opportunity to extend the bank efficiency literature. This study will expand the previous research by establishing those factors that determine differences in foreign bank efficiency in the host market. This will provide a detailed test of the limited form of the global advantage hypothesis of Berger *et al* (2000). Studies such as those by Dietsch and Lozano-Vivas (2000) and Beccalli (2004) have illustrated that cross-border differences in efficiency are affected by differences in environmental variables. This study will consider the impact of home nation and parent bank characteristics upon foreign bank efficiency in the host nation, thus adding a new perspective to the multinational bank efficiency literature.

A feature of this study is that foreign bank efficiency estimates will be drawn from a comparison of domestic banks in Australia with foreign banks in Australia, thus enabling this study to determine those factors which influence differences in efficiency for banks operating multinationally. The model of foreign bank efficiency in Australia that will be tested is based upon the previous work of Williams (2003, 1998a, 1998b), with some appropriate modifications due to the differences in research question being addressed.

The results of this study will be of benefit to bank managers considering strategic objectives for offshore expansion, in particular determination of the appropriate host nations. Credit raters will find results of this study useful to provide a benchmark for assessing offshore strategies of banks undergoing ratings reviews, while regulators of banking systems will find these results informative when considering the appropriate regulatory responses to multinational bank entry into their country.

This study applies parametric distance functions (Coelli and Perelman, 1999) to obtain estimates of foreign bank efficiency. Factors determining foreign bank efficiency will be established by the application of extreme bounds analysis (Levine and Renelt, 1992), as modified by Sala–i–Martin (1997). This study finds that the limited global advantage hypothesis of Berger *et al* (2000) applies in the Australian context. Little evidence was found to support the application of defensive expansion theory, the results suggesing that following clients reduces profit creation efficiency. However, the processing of investment income flows acts to increase profit creation efficiency, but reduces the efficiency of transformation of physical inputs into outputs. The domination of the Australian market by the Big Four banks acts as a barrier to entry, reducing efficiency, particularly in the retail market, consistent with Williams (2003). This indicates that foreign banks competing with the incumbent banks over-used inputs in order to contest with the incumbent banks in terms of service delivery. However, there is some evidence to suggest that acquisition of a domestic bank active in retail banking reduces this barrier to entry. The results also suggest that internet-based banking delivery does not increase the efficiency of the profit creation process, at least in the initial phases of operation, and that parent profitability does not improve host market efficiency.

2. Literature review

In addressing the research question posed by this study, two areas of research endeavor are relevant, (i) those that consider the efficiency of foreign banks in the host nation, and (ii) those that consider foreign bank efficiency in Australia.

2.1. The efficiency of foreign banks in the host nation

The recent survey by Berger *et al* (2000) concluded that foreign banks are less efficient than the host nation financial institutions. This conclusion is the outcome of studies employing several different efficiency estimation methods as well as using several different samples. Hasan and Hunter (1996) and Mahajan *et al* (1996) both found foreign banks in the United States had lower cost efficiency, while De Young and Nolle (1996) found similar results for foreign bank profit efficiency. Berger *et al* (2000) considered both cost and profit efficiency of foreign banks in five different nations (France, Germany, Spain, the United Kingdom and the United States) and found foreign banks to be less cost and profit efficient than domestic banks on average. However, Berger *et al* (2000) also found that for 3 of the five nations considered, banks from the United States were on average more efficient than domestic banks. Miller and Parkhe (2002) considered fourteen different host nations, employing stochastic frontier estimation of an alternative profit function, also finding domestic banks to be more efficient than foreign banks. In considering these results Berger *et al* (2000) proposed two alternative hypotheses, (i) the home field advantage hypothesis and (ii) the global advantage hypothesis. Under the home field advantage, the liability of foreignness[1] imposes costs on foreign banks such that the domestic banks are more efficient than foreign banks. The alternative hypothesis of global advantage has two forms, the general form and the limited form. Under the general form of the global advantage hypothesis, efficient foreign banks from a variety of nations are able to operate across national borders at higher levels of efficiency than domestic banks. The main body of empirical evidence to date has rejected this hypothesis, as did Berger *et al* (2000). The limited form of the global advantage hypothesis proposes that banks from some nations are able to overcome the costs imposed by the liability of foreignness due to nation-specific factors.

Berger *et al* (2000) found the limited form of the global advantage hypothesis supported by the finding that banks from the United States were more efficient than domestic banks in three of five host nations. Beccalli (2004) also found that UK investment firms were more efficient than foreign investment firms in the UK, while also confirming the limited global advantage for both UK and Japanese investment firms operating in Italy, and Japanese investment firms in the UK. In contrast to Berger *et al* (2000) for banks, Beccalli (2004) found US investment firms to be less efficient than domestic investment firms. A recent study by Sturm and Williams (2004) considered foreign banks in Australia, and their results are also suggestive of the limited form of the global advantage hypothesis, finding that foreign banks in Australia were, on average more efficient than domestic banks. Sturm and Williams

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[1] The liability of foreignness are the costs borne by banks operating away from their home market, such costs include monitoring, staff turnover, diseconomies of scale for retail operations, and factors such as culture, language and market structure acting as barriers to entry (Miller and Parkhe, 2002).

(2004) suggested that the process that rationed foreign bank licences in Australia during deregulation selected banks possessing attributes that enabled these banks to overcome the liability of foreignness. Responding to the results of these recent studies, this research will determine those factors that act as a source of limited global advantage in determining bank efficiency.

2.2. Foreign Bank efficiency in Australia

There have been several studies that have considered bank efficiency in Australia, with the results to date surveyed by Sturm and Williams (2004).[2] Of these studies, two have compared foreign and domestic bank efficiency. Sathye (2001) applied Data Envelopment Analysis (DEA) to a sample of 29 banks operating in Australia in 1996 (17 domestic banks and 12 foreign banks) and concluded that there were no significant differences between domestic and foreign banks. Sturm and Williams (2004) employed a wider ranging study both in terms of method and sample, considering thirty-nine banks between 1998 and 2001, with nineteen foreign banks and twenty domestic banks. The domestic banks were categorized as Big Four to represent the four large banks that dominate the Australian banking system in terms of size and Other Domestic banks to reflect the smaller, mainly regional and retail banks. Sturm and Williams (2004) employed non-parametric methods (DEA and Malmquist Indices) as well as stochastic frontier estimation. The results presented by Sturm and Williams (2004) emphasised the non-parametric estimation, with the stochastic frontier estimates used to confirm the conclusions drawn from DEA and Malmquist Index analysis. It was concluded that foreign banks were more efficient than domestic banks mainly due to superior scale efficiency. It was suggested that these results support the limited form of the global advantage hypothesis. Sturm and Williams (2004) suggested that the process of bank licence allocation that occurred during the early phases of Australian bank deregulation selected those banks with characteristics allowing them to overcome the liability of foreignness. It was concluded that diversity of bank types operating in a particular nation are an important source of ongoing

[2] A recent study by Neal (2004) included both domestic and foreign banks in the sample, but did not directly compare domestic and foreign banks. The sample in Neal (2004) is smaller that than employed by Sturm and Williams (2004).

innovation and efficiency. This paper will extend this previous study by determining which foreign bank characteristics are the sources of these valuable effects.

3. Method

3.1. Intermediation approach

Consistent with the previous literature in this area, this study will apply the intermediation approach to bank production (Berger and Humphrey, 1992; Berger and Mester, 1997). In the intermediation approach a bank is viewed as employing inputs such as deposits, staff and equity to produce outputs such as loans and off balance sheet items. As discussed by Berger *et al* (1993), results of efficiency estimates can be sensitive to the specification of inputs and outputs. In order to control for this effect it is intended to specify several different combinations of inputs and outputs. This will commence from a parsimonious balance sheet specification, in which banks use equity, employees and deposits to produce loans and off balance items (Model 1), as applied by Allen and Rai (1996), Chang *et al* (1998) and Sturm and Williams (2004). Following this base-line approach, additional outputs will be specified, in which loans are divided into retail components (Model 1a), and additional wholesale activity is included (Model 1b), to determine if this sensitivity analysis produces any further insight. Further sensitivity analysis will be conducted by applying an income-based specification of inputs and outputs as applied by Avkiran (1999 and 2000) and Sturm and Williams (2004) (Model 2). The income-based specification will consider inputs as interest expenses and non-interest expenses, while outputs will be specified as net interest income and non-interest income. Table 1 provides a summary of these models. The changes in model specification will result in some changes in sample composition due to data availability.

[INSERT TABLE 1 ABOUT HERE]

3.2. Technique

As this data set does not contain input or output prices for all banks, the parametric input-distance function proposed by Coelli and Perelman (1999) will be applied. This approach allows maximum likelihood estimation of a translog function using multiple outputs and inputs. We allow a time trend to influence the efficiency of the banks to reflect the impact of technology shifts and other time-dependent effects.

Following Coelli and Perelman (1999), to define an input-distance function we begin by defining the production technology of the bank using the input set, $L(y)$, which represents the set of all input vectors, $x \in R_+^K$, which can produce the output vector, $y \in R_+^M$. That is,

(1) $$L(y) = \{x \in R_+^K : x \text{ can produce } y\}.$$

We assume that the technology satisfies the axioms listed in Färe and Primont (1995). The input-distance function is then defined on the input set, $L(y)$, as

(2) $$D(x, y) = \max\{\theta : (x/\theta) \in L(y)\}.$$

$D(x, y)$ is non-decreasing, positively linearly homogeneous and concave in x, and decreasing in y. The distance function, $D(x, y)$, will take a value which is greater than or equal to one if the input vector, x, is an element of the feasible input set, $L(y)$. That is, $D(x, y) \geq 1$ if $x \in L(y)$. Furthermore, the distance function will take a value of unity if x is located on the inner boundary of the input set.

The translog input distance function for the case of M outputs and K inputs is specified as

(3) $$\begin{aligned} \ln D = {} & \alpha_0 + \sum_{m=1}^{M} \alpha_m \ln y_m + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M} \alpha_{mn} \ln y_m \ln y_n \\ & + \sum_{k=1}^{K} \beta_k \ln x_k + \frac{1}{2}\sum_{k=1}^{K}\sum_{l=1}^{K} \beta_{kl} \ln x_k \ln x_l \\ & + \sum_{k=1}^{K}\sum_{m=1}^{M} \delta_{km} \ln x_k \ln y_m \end{aligned}$$

Symmetry implies $\alpha_{mn} = \alpha_{nm}$ and $\beta_{kl} = \beta_{lk}$. The restrictions required for homogeneity of degree $+1$ in inputs are

(4) $$\sum_{k=1}^{K} \beta_k = 1; \sum_{l=1}^{K} \beta_{kl} = 0, k = 1, \ldots, K; \sum_{k=1}^{K} \delta_{km} = 0, m = 1, \ldots, M.$$

Lovell at al. (1994) use these homogeneity restrictions to transform the above equation into a form that can be estimated using ordinary least squares or maximum likelihood. Homogeneity in inputs implies that $D(\omega x, y) = \omega D(x, y)$, for any $\omega > 0$. Hence, if we arbitrarily choose one of the inputs, such as the Kth input, and set $\omega = 1/x_K$, we obtain $D(x/x_M, y) = D(x, y)/x_K$. For the translog form this provides

$$
\begin{aligned}
\ln\left(\frac{D}{x_K}\right) &= \alpha_0 + \sum_{m=1}^{M}\alpha_m \ln y_m + \frac{1}{2}\sum_{m=1}^{M}\sum_{n=1}^{M}\alpha_{mn}\ln y_m \ln y_n \\
&+\sum_{k=1}^{K-1}\beta_k \ln x_k^* + \frac{1}{2}\sum_{k=1}^{K-1}\sum_{l=1}^{K-1}\beta_{kl}\ln x_k^* \ln x_l^* \\
&+\sum_{k=1}^{K-1}\sum_{m=1}^{M}\delta_{km}\ln x_k^* \ln y_m,
\end{aligned} \tag{5}
$$

where $x_k^* = x_k / x_K$.

Also observe that if we wish to impose constant returns to scale upon this input distance function, we must impose homogeneity of degree -1 in outputs. This involves the additional constraints

$$
\sum_{k=1}^{K}\alpha_k = -1; \sum_{k=1}^{M}\delta_{km} = 0, k = 1,...,K. \tag{6}
$$

By noting that $\ln(D/x_K) = \ln(D) - \ln(x_K)$ and only imposing homogeneity of degree $+1$ in inputs, we can write our Model 1 into the following form

$$
\begin{aligned}
q &= \alpha_0 - \alpha_l l - \alpha_o o - \frac{1}{2}\alpha_{ll} l^2 - \alpha_{lo} lo - \frac{1}{2}\alpha_{oo} o^2 \\
&-\beta_e e^* - \beta_a a^* - \frac{1}{2}\beta_{ee} e^{*2} - \beta_{ea} e^* a^* - \frac{1}{2}\beta_{aa} a^{*2} \\
&-\delta_{le} le^* - \delta_{la} la^* - \delta_{oe} oe^* - \delta_{oa} oa^* + d,
\end{aligned} \tag{7}
$$

where $q = \ln EQCP$, $l = \ln LAOR$ (output 1), $o = \ln OBSA$ (output 2), $e^* = \ln \frac{EMPL}{EQCP}$, $a^* = \ln \frac{DABF}{EQCP}$, and $d = \ln D$. With EQCP = Equity Capital; LAOR = Loans; OBSA = Off Balance Sheet Activity; EMPL = Employee Numbers; DABF = Deposits

Using the dependent variable q and the 14 explanatory variables (not including d) which follow from the above equation, we have used FRONTIER (Version 4.1) to estimate the frontier and the implied technical efficiency.

The FRONTIER program follows a three-step procedure in estimating the maximum likelihood estimates of the parameters of a stochastic frontier production function. The three steps are:

1. Ordinary Least Squares (OLS) estimates of the function are obtained. All coefficient estimates with the exception of the intercept will be unbiased.
2. A two-phase grid search of γ is conducted, with the coefficient parameters (except the intercept) set to the OLS values and the intercept and σ^2 parameters adjusted according to the corrected ordinary least squares formula

presented in Coelli (1995). Any other parameters are set to zero in this grid search.

3. The values selected in the grid search are used as starting values in an iterative procedure (using the Davidson-Fletcher-Powell Quasi-Newton method) to obtain the final maximum likelihood estimates.

Imposing constant returns to scale (i.e. also impose homogeneity of degree -1 in outputs) gives the following equation with 11 explanatory variables:

$$
\begin{aligned}
&q-o=\alpha_0-\alpha_l\left(l-o\right)-\frac{1}{2}\alpha_{ll}l^2-\alpha_{lo}lo-\frac{1}{2}\alpha_{oo}o^2 \\
(8)\qquad &-\beta_e e^*-\beta_a a^*-\frac{1}{2}\beta_{ee}e^{*2}-\beta_{ea}e^*a^*-\frac{1}{2}\beta_{aa}a^{*2} \\
&-\delta_{le}\left(le^*-oe^*\right)-\delta_{la}\left(la^*-oa^*\right)+d.
\end{aligned}
$$

The remaining parameters β_q, β_{eq}, β_{aq}, δ_{lq}, δ_{oq}, α_o, δ_{oe} and δ_{oa} can be calculated using the homogeneity restrictions.

Homogeneity of degree $+1$ in inputs:

(9) $\beta_q=1-\beta_e-\beta_a;\beta_{eq}=-\beta_{ee}-\beta_{ea};\beta_{aq}=-\beta_{ea}-\beta_{aa};$

(10) $\delta_{lq}=-\delta_{le}-\delta_{la};\delta_{oq}=-\delta_{oe}-\delta_{oa}.$

Homogeneity of degree -1 in outputs:

(11) $\alpha_o=-1-\alpha_l;\delta_{oe}=-\delta_{le};\delta_{oa}=-\delta_{la}.$

The model we use to estimate the above specification is taken from Battese and Coelli (1995) and may be expressed as:

(12) $Y_{it}=X_{it}+\left(V_{it}-U_{it}\right),$

where $i=1,...,N$, $t=1,...,T$, Y_{it} equals the dependent variable (q_{it} or $\left(q-o\right)_{it}$), X_{it} is the set of (14 or 11) explanatory variables. The V_{it} are random variables which are assumed to be iid $N\left(0,\sigma_V^2\right)$, and independent of the U_{it} which are non-negative random variables which are assumed to account for technical inefficiency in production and are assumed to be independently distributed as truncations at zero of the $N\left(m_{it},\sigma_U^2\right)$ distribution. Furthermore,

(13) $m_{it}=\eta_0+\eta_t t,$

where t is a time trend which may influence the efficiency of a firm, and η_0 and η_t (labelled *delta 0* and *delta 1* in FRONTIER's output file) are parameters to be estimated.

[Note that in case we do not include a time trend, $U_{it} = U_i exp\left(-\eta\left(t-T\right)\right)$, where the U_i are non-negative random variables which are assumed to account for technical inefficiency in production and are assumed to be iid as truncations at zero of the $N\left(\mu, \sigma_U^2\right)$ distribution, where η and μ are parameters to be estimated.]

We use the parameterisation from Battese and Corra (1977), replacing σ_V^2 and σ_U^2 with $\sigma^2 = \sigma_V^2 + \sigma_U^2$ and $\gamma = \frac{\sigma_U^2}{\sigma_V^2 + \sigma_U^2}$. The log-likelihood function of this model is presented in the appendix in Battese and Coelli (1993). [3]

3.3. Second-stage model

Williams (2003) developed a model of factors determining multinational bank profits in the host nation. This model will be applied to the estimates of bank efficiency, as an alternative measure of bank performance, to determine if those factors that determine multinational bank profits in the host nation also determine multinational bank efficiency in the host nation. This approach will extend Berger *et al* (2000), by determining whether differences in multinational bank efficiency are due to host nation effects (such as economic growth or trade patterns), parent bank effects (such as parent size and profitability), or host market effects (such as market concentration). In order to address this question adequately, estimates of multinational bank efficiency must be drawn from frontier estimation that includes domestic (host nation) banks in the sample. These estimates will be then used as dependent variables in second stage regressions to establish which factors drawn from the model employed by Williams (2003) are relevant to the determination of bank efficiency.

While efficiency may not always translate into profitability due to factors such as asset quality and the impact of competitive pricing, it would be expected *a priori* that efficient banks are generally more profitable. Thus, factors that determine differences

[3] The exposition of Models 1a, 1b and 2 are contained in Appendix 1.

in bank profits, as modeled by Williams (2003) would be a relevant starting point to model differences in observed bank efficiency. Following the advice provided by Coelli *et al* (1998, p 171) if the variables used as inputs and outputs are highly correlated with the variables used in the second step regressions, then any results from second step regressions are potentially biased. As this study intends to use both domestic and multinational factors to explains differences in estimated bank efficiency, this issue should be somewhat ameliorated. Further, some variables employed by Williams (2003) will be omitted from the second stage regressions as they will have been used as either inputs or outputs in the estimation of the parametric distance functions from which the efficiency estimates are drawn. It is intended that these regressions will determine which factors result in differences in observed multinational bank efficiency.

Williams (2003) developed and tested a model of multinational bank profits that reflected both domestic and multinational determinants of bank profits. It was found that a model which combines elements drawn from both the domestic bank profits literature and the multinational banking literature resulted in a small increase in explanatory power as compared to a purely multinational model. This small increase in explanatory power did, however, generate additional insights into the policy and strategic decisions of multinational banks operating in Australia. Of particular note was the negative impact competitor market share had upon foreign bank profits. Williams (2003) also indicated that there was a need for further research that considered foreign bank efficiency.

3.3.1. Variables for second-stage regression

Williams (2003) employed competitor market share to measure the degree of host market competition confronting foreign banks in the host market. Competitor market share was specified as the market share of the four largest banks plus the market share of all other banks in the host market of the same nationality. Market share was defined in terms of assets. It was argued that the dominance of the Australian market by the four major banks (Big 4) acted as a barrier to entry with the large incumbent banks acting as local monopolists. Such dominance required the foreign banks to be price competitive, and so reducing their observed profits. Further, consistent with the defensive expansion hypothesis that banks follow their clients abroad (Williams, 2002), the next most important level of competition faced by foreign banks would be those banks from the same nation also seeking the same client base as beachhead into the host nation (Fieleke, 1977), thus the competition offered by foreign banks of the same nationality is also relevant to measure the level of barrier to entry faced by foreign banks in Australia.

Williams (2003) found that foreign banks profits were negatively related to competitor market share, however this may not necessarily also apply for efficiency. Such competition may result in increased efficiency in the host market, which due to the level of competition in pricing, particularly in the wholesale market, may not be reflected in higher foreign bank profit, despite higher efficiency. Foreign banks are particularly active in the wholesale market, (Williams, 2003), thus, efficiency in a competitive market may not necessarily result in increased profits.

While Williams (2003) did not find foreign bank profits in Australia to have a significant relationship with their parent profitability, Focarelli and Pozzolo (2001, p. 2326) have argued that parent profitability acts as one possible measure of parent efficiency. Those banks operating multinationally possess skills and attributes that enable them to operate in the host market and so overcome the liabilities of foreignness. If a foreign banks' parent is more efficient in the home market this provides a possible source of a comparative advantage for the bank to apply in the host market and so increase its efficiency in the host market (Williams, 1997). Given the argument above it is possible that foreign bank parent efficiency, as measured by profitability does not increase foreign bank profits in the host market, but does increase foreign bank efficiency. This study will use both Home Return on Assets (ROA) and Home Net Interest Margins (NIM) to measure parent Profits.

The defensive expansion hypothesis considers that banks expand offshore to defend their existing bank-client relationship (Brimmer and Dahl, 1975, Williams, 2002). As surveyed by Williams (2002) there is considerable evidence advanced to support this hypothesis in terms of bank size, while the evidence supporting this hypothesis in terms of bank profits is less clear-cut. In the Australian case Williams (1996, 1998a, 1998b, 2003) has found little support for a significant relationship between foreign bank profits and defensive expansion measures such as investments, exports or bilateral trade (imports plus exports). Following the argument of Williams (2002) that portfolio investment does not necessarily require a physical presence, while direct investment is more closely aligned with the need for a physical presence, direct investment (excluding portfolio investment) will be used to measure investments from the foreign bank's home nation into Australia. As the evidence has strongly supported the application of the defensive expansion hypothesis to foreign bank size, both internationally and in Australia, it is possible that foreign banks that follow their clients abroad benefit from increased size and thus, possibly, increased efficiency, but that this outcome is not reflected in reported profits.

Parent size has been found to have an important role in determining the size of foreign banks in the host nation (Cho, 1985, Williams 1998a and 1998b). However, little evidence has been found to suggest a relationship between parent size and profits in the host nation. Tschoegl (2003) has suggested that the largest bank in each nation is the most likely candidate for successful offshore expansion, while smaller banks have reduced host nation success. This study will consider two measures of parent size, log of assets (measured in AUD) and log of equity, to determine if parent size impacts upon measured foreign bank efficiency in the host market. As it is possible that exchange rate effects impact upon the measurement of parent size, this study will translate the parent size measures into Australian dollars (AUD) using two different exchange rates; (i) the average exchange rate for the relevant financial year; and (ii) the average exchange rate for the relevant balance month.

Increased home nation growth has been argued by Moshirian (2001) and Williams (2003) to reduce the attractiveness of offshore investment. Investing offshore when the domestic market is experiencing rapid growth results in the bank bearing an opportunity cost. Thus, the bank that chooses to invest offshore is bearing an opportunity cost of reduced domestic investment. This opportunity cost will be measured in this case by the growth rate of the home nation GDP. Williams (2003) found that foreign bank profits in Australia were a positive function of home nation GDP growth. It was suggested by Williams (2003) that this result reflected a substitution effect between international banking (offshore activity conducted from the home market) and multinational banking (offshore activity conducted offshore).

This study will consider if home nation GDP growth has any impact upon efficiency in the host market.

Nations with higher GDP per capita have more efficient domestic financial systems (Buch and DeLong, 2004) and so are more likely to be able to export efficient practices, consistent with the previous discussion of parent bank profits. Further, Buch and DeLong (2004) argued that nations with higher levels of economic development as represented by GDP per capita are also more likely to acquire banks in other nations. They found that banks in nations with lower GDP per capita are more likely to be targets in cross-border mergers. It was concluded that banks from developed nations are more likely to act as acquirers in cross-border mergers and this was presumed to be due to their higher efficiency. This study will determine if higher home market financial development (as measured by GDP per capita) results in higher efficiency in the host market.

Due to the liability of foreignness, domestic incumbents are likely to have advantages over the new foreign entrants. To overcome this disadvantage, foreign banks must possess compensating advantages. One possible advantage is experience in operating in the host market. Tschoegl (1982) suggested that experience has two dimensions; (i) generic experience of cross border operations and, (ii) specific experience of operating in the particular nation. Williams (1996) found that Japanese bank size in Australia was a positive non-linear function of time in Australia. However, the larger studies of Williams (1998a and 1998b) found no evidence that experience in the host nation impacted upon either profits or size. It is possible that host nation experience impacts upon efficiency, while not affecting foreign bank profits or size. This study will measure experience in the host market as the number of years between the sample year and the year of first transaction based activity.[4]

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[4] Measures of generic international experience such as numbers of countries of operation and Euromarket activity tend to be highly correlated with parent size measures (Cho, 1985), size measures are already included in this model.

3.3.2. Control Variables

The limited form of the global advantage hypothesis considers that banks from some nations are able to overcome the liability of foreignness due to nation specific factors (Berger *et al*, 2000). It is possible that the nation specific factors employed in this model do not capture all the dimensions of nation-specific factors that allow a bank to overcome the liability of foreignness. Thus dummy variables for nationality will be included in the model to capture any exogenous nationality effects not otherwise controlled for and to allow comparison with the results of Williams (2003, 1998a and 1998b). A further dummy variable will be included to represent commonality of national language. Tschoegl (2003) and Buch and DeLong (2004) have argued that if the home and host nation share a common language this can act as a measure of reduced cultural distance so reducing the liability of foreignness. Thus a dummy variable will be included for all foreign banks whose home nation has English as a primary language. It is also possible that the credit rating of the parent bank may reflect factors impacting upon efficiency in the host nation. Thus a measure reflecting the ranked credit rating of the parent bank will also be included in the analysis.[5]

3.4. Extreme Bounds Analysis and Model Uncertainty

In this case the economic theory discussed above does not provide the researcher with a strong framework or prior evidence regarding factors determining foreign bank efficiency. The evidence discussed above was drawn mainly from the literature considering foreign bank size or profits, not efficiency. While this evidence provides a theoretical background to the choice of relevant variables, it does not directly address the research question posed in this paper. This issue will be dealt with by the application of extreme bounds analysis (Leamer, 1983; Levine and Renelt, 1992) to allow the examination of the robustness of the variables of interest to model specification (de Haan and Sturm, 2000). As suggested by Sala-i-Martin (1997) the test applied under extreme bounds analysis are too strong for any variable to pass, and as such the distribution of the estimated coefficients should be examined.

[5] The ranked credit rating will consider all banks rated as AAA as having a rank of 1, if there are 3 banks with a AAA rating, then the bank with the next lowest rating (Aa1) will be ranked 4, and so forth.

In extreme bounds analysis, an equation of the following general form is estimated:

(14) $Y_{it} = \alpha M_{it} + \beta F_{it} + \gamma Z_{it} + u_{it}$,

where Y_{it} is the dependent variable, i.e. in this case foreign bank efficiency, M_{it} a vector of standard explanatory variables drawn from the literature, F_{it} the explanatory variable of interest, Z_{it} a vector of up to three (Levine and Renelt, 1992) possible additional explanatory variables, and u_{it} the usual error term.

This approach commences with a vector of explanatory variables that are always significant, a variable F is then added to the model and an additional vector, Z, of up to three additional variables are then added to the model. The vector Z is based upon economic theory as being suggested by theory as being related to Y, with, however, less conclusive empirical support than the vector M. The process of respecifying the vector Z continues until all possible combinations of the Z vector have been exhausted. From this process a vector of the estimated β coefficients and their associated standard errors are obtained. The lowest value minus twice its standard deviation is calculated, as is the highest value plus twice its estimated standard deviation. The extreme bounds test considers these to be the highest and lowest observed β. If these values encompass both positive and negative values then it is concluded that the variable F is not robustly related to Y (Levine and Renelt, 1992). As argued, however, by Temple (2000), it is rare for any model to dominate all alternatives in all dimensions. Sala-i-Martin (1997) argues that this approach sets too rigid a threshold and instead the distribution of the estimated β vector and its associated standard deviation should be considered. It is suggested, instead, that if 90% of the estimated β coefficients are significantly different from zero at the five percent significance level, then the variable F should be considered as being strongly correlated with the dependent variable (Sturm and de Haan, 2004). Further, the cumulative distribution function of β should also be considered. As stated by Sala-i-Martin (1997), if a large percentage of the estimated β lie on one side of zero, it is more likely to be correlated with Y than a variable with a far smaller percentage of its estimated coefficients lying to one side of zero. Thus this paper will use the approach of Sala-i-Martin, as applied by de Haan and Sturm (2000) and Sturm and de Haan

(2004). Thus we will report not only the extreme bounds for each parameter, but also the unweighted parameter estimate of the β and its unweighted standard deviation, as well as the unweighted cumulative distribution function and the percent of the estimated β significant at the five percent level.

Unlike the situation in Sala-i-Martin (1997) this study is not able to refer to a prior stream of research into the determinants of foreign bank efficiency to establish those variables that should comprise the M vector; this study is the first that these authors are aware that models the determinants of foreign bank efficiency. Thus the basic model will commence with an intercept only and a robust model will be developed from that point.

Due to the differences in both research question and methodology, the second stage regressions employed in this study will differ from the models employed by Williams (2003). As discussed by Coelli *et al* (1998, p 171), if the input and output variables are highly correlated with the explanatory variables used in the second stage regressions, then the results for the secondary regression are potentially biased. As this study uses as inputs or outputs variables that have been used by Williams (2003) as explanatory variables (or are expected to be highly correlated with inputs or outputs), there have been some changes to the models of Williams (2003). These changes particularly affect the model that adds domestic market factors to the multinational market as many of the domestic market factors included in Williams (2003) are endogenous to the models used to generate the efficiency estimates.

3.5. Sample

This study will consider banks operating in Australia between 1988 and 2001. The banks in the sample will be categorized as Big 4, Other Domestic and Foreign, following Sturm and Williams (2004). The primary data source is the bank's annual reports with additional details being obtained from the Reserve Bank of Australia (RBA) *Bulletin* and the Australian Prudential Regulation Authority (APRA). Details regarding foreign bank parents were obtained from Moody's *Credit Opinions: Financial Institutions*. Foreign bank home nation trade data was obtained from the

Australian Bureau of Statistics and the parent nation data was sourced from the IMF's International Financial Statistics.

The characteristics of the sample for each model are listed in Table 2, while Table 3 has the descriptive statistics of the inputs and outputs to be used in the estimation of bank efficiency. All values in Table 3 are in thousands of Australian dollars, except for employee numbers. Table 3 shows the Foreign banks are proportionately more active in off balance sheet financing, the Other Domestic banks are proportionately more active in housing finance, unsurprisingly, the Big Four banks are the largest. It should be noted that some of the foreign banks have no housing loans. This is a strategic choice by these banks not to conduct this type of financing; and as such is a valid output decision. As this model is estimated in logarithmic form; 1 was added to all values to allow logarithms to be taken of all values.[6]

[INSERT TABLES 2 AND 3 ABOUT HERE]

4. Results

4.1. Stochastic frontier results

The results for each of the models of bank efficiency are summarized in Table 4, with the correlations between the models also shown in Table 4. The results are consistent with Sturm and Williams (2004), in that the correlations between Models 1, 1a and 1b are highest, while the correlations with Model 2 are lower. The average estimated efficiency of between 82 per cent and 86 per cent is marginally higher than found by Sturm and Williams (2004) for their DEA estimates, which would be accounted by the differences in technique and small differences in sample.[7] The overall pattern of efficiency estimates is similar to Sturm and Williams (2004) in that the Foreign Banks are most efficient early in the sample period, with the Big Four and Other Domestic

---

[6] In the case of foreign banks, restructures of the Australian banks resulted in that bank being treated as a new bank, as in the case of the merger of Bank of Tokyo and Mitsubishi Bank in Japan to result in the establishment of Bank of Tokyo/Mitsubishi Australia.

[7] The sample employed in this study includes two additional observations for the Other Domestic Banks and 5 additional observations for the Foreign Banks.

Bank being more efficient in the aftermath of the recession of the early 1990s. Unlike Sturm and Williams (2004) the Other Domestic Banks are less frequently the most efficient bank group on average. What is also interesting about these results is that while on average the foreign banks are less efficient than the domestic banks over the entire sample period, a foreign bank represented the highest measured efficiency for each of the four models of efficiency, although not the same foreign bank for each model. This result would tend to support the limited global advantage hypothesis of Berger *et al* (2000). The parent characteristics data is shown in Table 5.

[INSERT TABLES 4 AND 5 ABOUT HERE]

4.2. Second stage results

For each model extreme bounds analysis was used to develop the most parsimonious model. This model can be considered to the baseline model or the M vector for this study, and was found to be robust to model specification. In the case of Model 1 in Table 6, 2047 alternative specifications of the Z vector were then applied to determine the robustness of the model to alternative specification. In the case of each baseline robust model, an additional explanatory variable was then added to the model and the extreme bounds approach was repeated. In this case the baseline model was treated as the M vector with the additional variable treated as the F variable of additional interest. The Z vector of up to three additional variables was then added to the model to determine the robustness of this additional variable to changes in model specification. In the case of Model 1 in Table 6, this process involved an additional 1793 alternative model specifications being considered for each of 22 additional explanatory variables. This process was conducted to ensure that the baseline model did not omit any variables with additional explanatory power. In each case the baseline model was also estimated as a panel regression using random effects estimation, with these results also shown in Table 6.[8]

[8] In some cases the parent firm or home nation characteristics were found to be highly correlated with another similar variable, such as Home Return on Assets and Home Net Interest Margins. In these cases the variable that exhibited the highest correlation with the estimated efficiency score was included in the Extreme Bounds Analysis and the alternative variable was removed in order to reduce potential multicollinearity.

[INSERT TABLE 6 ABOUT HERE]

Consistent with Williams (2003), little evidence was found to support the following clients (defensive expansion) effect. In the case of Models 1 and 1b, the coefficient for Home Nation Investment Income is positive and significant. This variable is measured using the IMF's balance of payment conventions, in that a negative value represents a flow from the host nation (Australia) to the home nation. Given this measurement, as income flows from Australia to the home nation *reduce*, so foreign bank efficiency increases. Given that investment income flows are not necessarily correlated with investment flows in a given year, then it is unlikely that this reflects a client following effect. In the case of Model 2, as investment income from the host nation to the home nation increase, so the efficiency of the profit creation process increases. This would suggest that these investment income flows generate fee income for the foreign banks, potentially via transaction processing and foreign exchange services, which is profitable, but that offering services of this type for this purpose is not necessarily efficient in terms of physical inputs and outputs.

Previous Australian studies have found that following clients acts to increase size (Williams, 1998b), but not profits (Williams, 2003). This difference may be explained by considering the results for the profit-based model of bank efficiency (Model 2), which found bank efficiency in profit creation is reduced by following clients as represented by Home Nation Capital Stock. Taken together with the results of previous studies, it can be concluded that following clients will increase size and some types of efficiency but not profits in the host nation.

The retail model of bank efficiency (Model 1a) demonstrates the impact of barriers to entry for foreign banks, as Competitor Market Share 1 was found to be negative and significant, while a dummy variable indicating the Bank of Western Australia was positive and significant. This result is particularly interesting as the Bank of Western Australia is the only foreign-owned bank in this study representing the acquisition of a domestic retail bank by a foreign bank.[9] Thus, the results for Model 1a indicate that for the foreign banks the large market share of the incumbent Big Four banks acted as a significant barrier to entry, reducing foreign bank efficiency, consistent with Williams (2003) for foreign bank profits. Thus the foreign banks wishing to compete with the incumbent banks operated at a less efficient level, indicating the over-use of inputs in order to compete, so reducing efficiency, which was particularly apparent in the retail market, where delivery networks are more important than in wholesale banking. The results for the Bank of WA confirm the importance of delivery systems, as by taking over a regional bank these efficiency costs were reduced and Bank WA with foreign ownership was able to operate more efficiently than the other foreign banks, when retail activity is factored into the output mix.

The wholesale model of bank efficiency (Model 1b) found that banks from the United Kingdom are more efficient on average. As this result may have represented a cultural or experience effect, a dummy variable representing all nations where the main language is English was also tested as well as a measure representing number of years of operation in Australia. Neither of these variables was found to be significant in the robustness tests for any model of bank efficiency. Thus, this result for United Kingdom ownership again confirms the limited form of the global advantage hypothesis of Berger *et al* (2000). However, this result does differ from Berger *et al* (2000) in that no evidence is found of banks from the United States displaying higher efficiency. Parent bank profits, as measured by parent NIM, were found to be efficiency reducing for Model 1b indicating that parent profitability does not translate into efficiency in the host market.

Model 2 provides some interesting insights into the following clients effect, with Home Nation Capital Stock acting to reduce the efficiency of the process of profit creation. As discussed above this indicates that following clients does not increase profits in the host nation. A dummy variable representing ING Bank was found to have a significant negative relationship with efficiency as measured by Model 2. ING

---

[9] The acquisition of United Permanent Building Society by the National Mutual Royal Bank (a joint venture involving the Royal Bank of Canada) is included in the sample.

bank proves largely an internet-based banking service, with the sample data for ING covering 2000 and 2001. This result indicates that a strategy focused upon internet delivery does not improve the efficiency of profit creation, especially during the initial phases of internet operation. This is most likely due to the initial start up costs associated with establishing an internet-based presence in a foreign market.

5. Conclusions

This study has applied parametric distance functions to estimate the efficiency of foreign banks in Australia, and then employed extreme bounds analysis to determine a model of foreign bank efficiency that is robust to model specification. The limited global advantage hypothesis of Berger *et al* (2000) is supported by this study, with banks from the United Kingdom in particular being found to be more efficient than other foreign banks. It is found that following clients does not improve the efficiency of transforming inputs into outputs. However, following clients (defensive expansion) reduces the efficiency of the process of profit creation in the host nation. It was also found that the processing of investment income flows from the home nation reduces the efficiency of transformation of physical inputs into physical outputs, but that this processing improves the efficiency of the profit creation process. The market share of competitor banks, particularly the incumbent Big Four banks, acts as a barrier to entry to the retail market resulting in reduced efficiency due to the need to over-use inputs in order to compete with the dominant banks. The acquisition of a domestic bank reduces the impact of this barrier to entry to the retail market. However, internet banking seems to reduce the efficiency of the profit creation process and so this approach does not, in this case, offer the reduction in barriers to entry initially anticipated, at least in the startup phases.

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Appendix 1

Models 1a, 1b, and 2 can be shown to have the following forms:

Assuming homogeneity in inputs, model 1a (with 20 explanatory variables) can be written as

$$
\begin{aligned}
&q=\alpha_0-\alpha_{\bar{l}}\bar{l}-\alpha_o o-\alpha_h h\\
&-\frac{1}{2}\alpha_{\bar{l}\bar{l}}\bar{l}^2-\alpha_{\bar{l}o}\bar{l}o-\alpha_{\bar{l}h}\bar{l}h-\frac{1}{2}\alpha_{oo}o^2-\alpha_{oh}oh-\frac{1}{2}\alpha_{hh}h^2\\
&-\beta_e e^*-\beta_a a^*-\frac{1}{2}\beta_{ee}e^{*2}-\beta_{ea}e^*a^*-\frac{1}{2}\beta_{aa}a^{*2}\\
&-\delta_{\bar{l}e}\bar{l}e^*-\delta_{\bar{l}a}\bar{l}a^*-\delta_{oe}oe^*-\delta_{oa}oa^*-\delta_{he}he^*-\delta_{ha}ha^*+d,
\end{aligned}
\tag{A1.1}
$$

Where: $\bar{l}=\ln\left(LAOR-HOLO\right)$ (output 1) and $h=\ln HOLO$ (output 3). Where HOLO = Housing Loans.

Imposing constant returns to scale (i.e. also impose homogeneity of degree -1 in outputs) gives the following equation with 17 explanatory variables:

$$
\begin{aligned}
&q-o=\alpha_0-\alpha_{\bar{l}}\left(\bar{l}-o\right)-\alpha_h\left(h-o\right)\\
&-\frac{1}{2}\alpha_{\bar{l}\bar{l}}\bar{l}^2-\alpha_{\bar{l}o}\bar{l}o-\alpha_{\bar{l}h}\bar{l}h-\frac{1}{2}\alpha_{oo}o^2-\alpha_{oh}oh-\frac{1}{2}\alpha_{hh}h^2\\
&-\beta_e e^*-\beta_a a^*-\frac{1}{2}\beta_{ee}e^{*2}-\beta_{ea}e^*a^*-\frac{1}{2}\beta_{aa}a^{*2}\\
&-\delta_{\bar{l}e}\left(\bar{l}e^*-oe^*\right)-\delta_{\bar{l}a}\left(\bar{l}a^*-oa^*\right)-\delta_{he}\left(he^*-oe^*\right)-\delta_{ha}\left(ha^*-oa^*\right)+d,
\end{aligned}
\tag{A1.2}
$$

Assuming homogeneity in inputs, model 1b (with 20 explanatory variables) can be written as

$$
\begin{aligned}
&q=\alpha_0-\alpha_l l-\alpha_o o-\alpha_v v\\
&-\frac{1}{2}\alpha_{ll}l^2-\alpha_{lo}lo-\alpha_{lv}lv-\frac{1}{2}\alpha_{oo}o^2-\alpha_{ov}ov-\frac{1}{2}\alpha_{vv}v^2\\
&-\beta_e e^*-\beta_a a^*-\frac{1}{2}\beta_{ee}e^{*2}-\beta_{ea}e^*a^*-\frac{1}{2}\beta_{aa}a^{*2}\\
&-\delta_{le}le^*-\delta_{la}la^*-\delta_{oe}oe^*-\delta_{oa}oa^*-\delta_{ve}ve^*-\delta_{va}va^*+d,
\end{aligned}
\tag{A1.3}
$$

Where: $v=\ln INVM$ (output 3). Where INVM = Investments.

Imposing constant returns to scale (i.e. also impose homogeneity of degree -1 in outputs) gives the following equation with 17 explanatory variables:

$$
\begin{aligned}
& q-o=\alpha_0-\alpha_l(l-o)-\alpha_v(v-o) \\
& -\frac{1}{2}\alpha_{ll}l^2-\alpha_{lo}lo-\alpha_{lv}lv-\frac{1}{2}\alpha_{oo}o^2-\alpha_{ov}ov-\frac{1}{2}\alpha_{vv}v^2 \\
& -\beta_e e^*-\beta_a a^*-\frac{1}{2}\beta_{ee}e^{*2}-\beta_{ea}e^*a^*-\frac{1}{2}\beta_{aa}a^{*2} \\
& -\delta_{le}\left(le^*-oe^*\right)-\delta_{la}\left(la^*-oa^*\right)-\delta_{ve}\left(ve^*-oe^*\right)-\delta_{va}\left(va^*-oa^*\right)+d,
\end{aligned}
\tag{A1.4}
$$

Assuming homogeneity in inputs, model 2 (with 9 explanatory variables) can be written as

$$
\begin{aligned}
& y=\alpha_0-\alpha_n n-\alpha_r r-\frac{1}{2}\alpha_{nn}n^2-\alpha_{nr}nr-\frac{1}{2}\alpha_{rr}r^2 \\
& -\beta_x x^*-\frac{1}{2}\beta_{xx}x^{*2}-\delta_{nx}nx^*-\delta_{rx}rx^*+d,
\end{aligned}
\tag{A1.5}
$$

Assuming homogeneity in inputs, model 2(n) (with 9 explanatory variables) can be written as

$$
\begin{aligned}
& y=\alpha_0-\alpha_n n-\alpha_r r-\frac{1}{2}\alpha_{nn}n^2-\alpha_{nr}nr-\frac{1}{2}\alpha_{rr}r^2 \\
& -\beta_x x^*-\frac{1}{2}\beta_{xx}x^{*2}-\delta_{nx}nx^*-\delta_{rx}rx^*+d,
\end{aligned}
\tag{A1.6}
$$

Where: $y=\ln NONX$, $n=\ln NIIN$ (output 1), $r=\ln\left(INTR-INTX\right)$ (output 2), $x^*=\ln\frac{INTX}{NONX}$ and $d=\ln D$. Where NONX = Non Interest Expenses; NIIN = Non Interest Income; INTR = Interest Income; INTX = Interest Expense.

Imposing constant returns to scale (i.e. also impose homogeneity of degree -1 in outputs) gives the following equation with 7 explanatory variables:

$$
\begin{aligned}
& y-r=\alpha_0-\alpha_n(n-r)-\frac{1}{2}\alpha_{nn}n^2-\alpha_{nr}nr-\frac{1}{2}\alpha_{rr}r^2 \\
& -\beta_x x^*-\frac{1}{2}\beta_{xx}x^{*2}-\delta_{nx}\left(nx^*-rx^*\right)+d.
\end{aligned}
\tag{A1.7}
$$

Table 1: Summary of Models Employed:

	Inputs	Outputs
Model 1	(i) employees, (ii) deposits, (iii) equity capital.	(i) loans, (ii) off balance sheet activity.
Model 1a (retail model)	(i) employees, (ii) deposits, (iii) equity capital.	(i) loans less housing loans, (ii) housing loans, (iii) off balance sheet activity.
Model 1b (wholesale model)	(i) employees, (ii) deposits, (iii) equity capital.	(i) loans, (ii) investments, (iii) off balance sheet activity.
Model 2 (revenue model)	(i) interest expenses, (ii) non-interest expenses.	(i) net interest income, (ii) non-interest income.

Table 2: Sample Characteristics.

Panel A: Model 1

Year	Big4	Other Domestic	Foreign	Total
1988	2	3	13	18
1989	3	8	15	26
1990	3	8	13	24
1991	4	9	13	26
1992	4	9	12	25
1993	4	9	11	24
1994	4	10	11	25
1995	4	10	9	23
1996	4	10	6	20
1997	4	7	6	17
1998	4	5	4	13
1999	4	5	5	14
2000	4	5	4	13
2001	4	5	3	12

Model 1: Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans, (ii) off balance sheet activity

Panel B: Model 1a				
Year	Big4	Other Domestic	Foreign	Total
1988	2	1	3	6
1989	3	4	12	19
1990	3	8	13	24
1991	4	9	13	26
1992	4	9	12	25
1993	4	9	11	24
1994	4	10	11	25
1995	4	10	9	23
1996	4	10	6	20
1997	4	7	6	17
1998	4	5	4	13
1999	4	5	5	14
2000	4	5	4	13
2001	4	5	3	12

Model 1a: Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans less housing loans, (ii) housing loans (iii) off balance sheet activity.

Panel C: Model 1b				
Year	Big4	Other Domestic	Foreign	Total
1988	2	3	13	18
1989	3	8	15	26
1990	3	8	13	24
1991	4	9	13	26
1992	4	9	12	25
1993	4	9	11	24
1994	4	10	11	25
1995	4	10	9	23
1996	4	10	6	20
1997	4	7	6	17
1998	4	5	4	13
1999	4	5	5	14
2000	4	5	4	13
2001	4	5	3	12

Model 1b Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans, (ii) investments, (iii) off balance sheet activity.

Panel D: Model 2				
Year	Big4	Other Domestic	Foreign	Total
1988	4	8	7	19
1989	4	9	8	21
1990	4	10	7	21
1991	4	10	7	21
1992	4	10	7	21
1993	4	12	7	23
1994	4	10	7	21
1995	4	11	5	20
1996	4	11	4	19
1997	4	8	4	16
1998	4	9	5	18
1999	4	7	6	17
2000	4	8	7	19
2001	4	8	4	16

Model 2: Inputs: (i) interest expenses, (ii) non-interest expenses. Outputs: (i) net interest income, (ii) non-interest income.

Table 3: Descriptive Statistics.

All values in $A,000 except Employees.

Panel A: All banks					
Series	Obs	Mean	Std. Error	Minimum	Maximum
Deposits	334	16627473	31670293	2607	1.91E+08
Employees	341	7497.443	14146.1	43	50366
Housing loans	361	4080611	7811910	0	47679000
Loans	334	17246386	33448542	188471	2.08E+08
Non-interest income	321	494090.5	961215.6	1678	6522999
Off balance sheet activity	304	7925736	17324183	0	96141000
Equity capital	364	1699438	3484645	21999	23556999
Interest income	324	2030574	3564893	31235	19918999
Interest expense	322	1324700	2272543	6150	12958999
Investments	334	3599697	6158195	2700	45165999
Non-interest expense	283	872725.8	1440134	8131	8348999

Panel B: Big four banks:					
Series	Obs	Mean	Std. Error	Minimum	Maximum
Deposits	56	78631183	34541815	27577499	1.91E+08
Employees	56	38551.68	6608.154	22500	50366
Housing loans	56	18759232	9994634	4370841	47679000
Loans	56	81615712	38934619	26445398	2.08E+08
Non-interest income	56	2124322	1125816	626499	6522999
Off balance sheet activity	52	41359625	19934037	5510000	96141000
Equity capital	56	8674520	4393153	2491899	23556999
Interest income	56	9281054	2835641	4902799	19918999
Interest expense	56	5834337	2030585	3103399	12958999
Investments	56	14866742	6556399	6403099	45165999
Non-interest expense	56	3450101	1160910	1799699	8348999

Panel C: Other domestic banks					
Series	Obs	Mean	Std. Error	Minimum	Maximum
Deposits	134	6803024	7403338	267770	37853918
Employees	134	2242.269	2368.434	45	11495
Housing loans	139	2544646	3461435	0	20300100
Loans	134	6655576	7763194	188471	39698998
Non-interest income	133	233325.8	565917.8	1678	4331999
Off balance sheet activity	119	1392368	1877616	0	9826000
Equity capital	157	597804.6	815294.8	21999	3858999
Interest income	133	763401.3	764347	46361	3310999
Interest expense	133	538756.9	550860.8	6150	2457599
Investments	134	1932073	3369209	54484	29246999
Non-interest expense	131	334516.4	574008.3	22322	4260999

Panel D: Foreign banks					
Series	Obs	Mean	Std. Error	Minimum	Maximum
Deposits	144	1657115	2037772	2607	12322799
Employees	151	644.1722	788.0992	43	3311
Housing loans	166	414925.7	1093813	0	6386400
Loans	144	2069206	2564837	295810	16633098
Non-interest income	132	65217.27	107813.1	2121	580545
Off balance sheet activity	133	699485.6	893697.5	5772	5086258
Equity capital	151	258059.5	304297.4	21999	1576768
Interest income	135	271368.2	276123	31235	1344199
Interest expense	133	211849.2	198942.4	21494	947099
Investments	144	769885.5	914924.5	2700	5051665
Non-interest expense	96	103688.5	111617.8	8131	568217

Table 4: Average efficiency scores.

All Banks.

Series	Obs	Mean	Std.Error	Minimum	Maximum
Model 1	280	0.83	0.12	0.24	0.96
Model 1a	261	0.83	0.09	0.51	0.96
Model 1b	280	0.86	0.08	0.51	0.97
Model 2	272	0.87	0.10	0.16	0.97

Correlation between efficiency scores: All Banks.

Observations \ Correlation	Model 1	Model 1a	Model 1b	Model 2
Model 1	280	0.70	0.63	-0.03
Model 1a	261	261	0.61	-0.01
Model 1b	280	261	280	-0.08
Model 2	232	221	232	272

Foreign Banks.

Series	Obs	Mean	Std.Error	Minimum	Maximum
Model 1	125	0.80	0.17	0.24	0.96
Model 1a	112	0.83	0.11	0.51	0.96
Model 1b	125	0.85	0.10	0.51	0.97
Model 2	85	0.85	0.13	0.16	0.97

Correlation between efficiency scores: Foreign Banks.

Observations \ Correlation	Model 1	Model 1a	Model 1b	Model 2
Model 1	125	0.74	0.68	-0.15
Model 1a	112	112	0.64	-0.16
Model 1b	125	112	125	-0.17
Model 2	78	73	78	85

Model 1: Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans, (ii) off balance sheet activity.
Model 1a: Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans less housing loans, (ii) housing loans (iii) off balance sheet activity.
Model 1b Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans, (ii) investments, (iii) off balance sheet activity.
Model 2: Inputs: (i) interest expenses, (ii) non-interest expenses. Outputs: (i) net interest income, (ii) non-interest income.

Table 5.

Panel A: Descriptive statistics: Parent Characteristics.

Series	Obs	Mean	Std.Error	Minimum	Maximum
Efficiency Model 1	125	0.80	0.17	0.24	0.96
Efficiency Model 1a	112	0.83	0.11	0.51	0.96
Efficiency Model 1b	125	0.85	0.10	0.51	0.97
Efficiency Model 2	85	0.85	0.13	0.16	0.97
Home Return on Assets	132	0.63	0.62	-1.66	3.02
Home Nation Investment Income	127	-0.43	1.74	-3.53	2.34
Log (Relative GDP per capita)	132	0.14	0.48	-2.52	0.72
Competitor Market share	132	0.58	0.08	0.46	0.71
Ranked Home Credit Rating	109	97.38	54.74	16.00	183.50
Log(Home Assets) (Avg. Annual Ex Rate)	132	12.13	1.04	9.04	14.04
Log(Home Capital) (Avg. Annual Ex. Rate)	127	9.44	1.10	6.79	12.71
Home Net Interest Margin	121	2.52	1.37	-1.62	4.93
Trade with Australia as a share of GDP	129	0.03	0.02	0.00	0.06
Home nation capital flow	128	1.28	1.27	-0.67	6.05
Home nation capital stock	129	21.87	12.70	0.75	57.06
GDP per capita relative to Aust GDP per capita	132	-0.30	2.61	-6.37	9.06
Experience in Aust.	132	19.50	16.93	0.00	66.00
Dummy Canada	132	0.02	0.12	0.00	1.00
Dummy Germany	132	0.05	0.21	0.00	1.00
Dummy Hong Kong	132	0.01	0.09	0.00	1.00
Dummy Japan	132	0.26	0.44	0.00	1.00
Dummy Jordan	132	0.02	0.15	0.00	1.00
Dummy Singapore	132	0.05	0.21	0.00	1.00
Dummy Switzerland	132	0.02	0.15	0.00	1.00
Dummy UK	132	0.32	0.47	0.00	1.00
Dummy USA	132	0.25	0.43	0.00	1.00
Dummy English Language	132	0.58	0.49	0.00	1.00
Dummy Bank WA	132	0.06	0.24	0.00	1.00
Dummy ING	132	0.02	0.12	0.00	1.00

Panel B: Observations \ Correlation

	Efficienc y Model 1	Efficienc y Model 1a	Efficienc y Model 1b	Efficienc y Model 2	Home ROA	Home Nation Investment Income	Log (Relative GDP per capita)	Competitor Market Share	Ranked Home Credit Rating
Efficiency Model 1	125	0.739	0.681	-0.146	-0.268	0.251	-0.176	-0.284	-0.145
Efficiency Model 1a	112	112	0.635	-0.159	-0.16	0.159	-0.268	-0.251	-0.142
Efficiency Model 1b	125	112	125	-0.167	-0.341	0.263	-0.01	-0.307	-0.332
Efficiency Model 2	78	73	78	85	0.055	-0.31	-0.086	0.189	0.046
Home Return on Assets	125	112	125	85	132	-0.336	-0.152	0.285	-0.022
Home Nation Investment Income	120	108	120	82	127	127	-0.128	-0.744	-0.272
Log (Relative GDP per capita)	125	112	125	85	132	127	132	0.13	-0.105
Competitor Market Share	125	112	125	85	132	127	132	132	0.362
Ranked Home Credit Rating	102	95	102	72	109	107	109	109	109
Log (Home Assets) (Avg. Annual Ex. Rate)	125	112	125	85	132	127	132	132	109
Log (Home Capital) (Avg. Annual Ex. Rate)	120	107	120	83	127	122	127	127	104
Home Net Interest Margin	116	105	116	78	121	117	121	121	103
Trade with Australia as a share of GDP	122	109	122	82	129	127	129	129	107
Home Nation Capital Flow	121	108	121	81	128	126	128	128	106
Home Nation Capital Stock	122	109	122	82	129	127	129	129	107
GDP per capita relative to Aust GDP per capita	125	112	125	85	132	127	132	132	109
Experience in Australia	125	112	125	85	132	127	132	132	109
Dummy Canada	125	112	125	85	132	127	132	132	109
Dummy Germany	125	112	125	85	132	127	132	132	109
Dummy Hong Kong	125	112	125	85	132	127	132	132	109
Dummy Japan	125	112	125	85	132	127	132	132	109
Dummy Jordan	125	112	125	85	132	127	132	132	109
Dummy Singapore	125	112	125	85	132	127	132	132	109
Dummy Switzerland	125	112	125	85	132	127	132	132	109
Dummy UK	125	112	125	85	132	127	132	132	109
Dummy US	125	112	125	85	132	127	132	132	109
Dummy English Language	125	112	125	85	132	127	132	132	109

Dummy Bank WA	125	112	125	85	132	127	132	132	109
Dummy ING	125	112	125	85	132	127	132	132	109

	Log (Home Assets) (Avg. Annual Ex. Rate)	Log (Home Capital) (Avg. Annual Ex. Rate)	Home Net Interest Margin	Trade with Australia as a share of GDP	Home Nation Capital Flow	Home Nation Capital Stock	GDP per capita relative to Aust GDP per capita	Experience in Australia	Dummy Canada	Dummy Germany
Efficiency Model 1	0.15	0.06	0.145	-0.127	-0.115	-0.208	0.103	-0.137	0.109	0.152
Efficiency Model 1a	0.059	-0.023	0.155	-0.213	0.086	-0.033	0.192	-0.158	0.127	0.181
Efficiency Model 1b	0.182	0.169	-0.183	-0.09	-0.074	-0.207	0.14	-0.344	0.123	0.114
Efficiency Model 2	-0.134	-0.097	0.044	0.012	-0.181	0.132	-0.165	-0.034	-0.101	0
Home Return on Assets	-0.362	-0.166	0.27	-0.33	0.136	0.15	0.231	0.19	-0.013	-0.057
Home Nation Investment Income	-0.13	0.048	-0.035	0.047	-0.202	-0.549	0.244	-0.212	0.051	0.065
Log (Relative GDP per capita)	0.517	0.412	-0.21	0.749	0.001	-0.071	-0.206	0.033	-0.012	0.014
Competitor Market Share	0.14	-0.062	0.007	-0.018	0.061	0.44	-0.471	0.232	-0.153	-0.151
Ranked Home Credit Rating	-0.25	-0.255	0.395	0.115	0.125	0.437	-0.244	0.547	-0.08	-0.36
Log (Home Assets) (Avg. Annual Ex. Rate)	132	0.524	-0.231	0.539	0.144	0.117	-0.365	-0.151	-0.058	0.043
Log (Home Capital) (Avg. Annual Ex. Rate)	127	127	-0.427	0.488	0.056	-0.187	0.071	-0.361	0	-0.004
Home Net Interest Margin	121	116	121	-0.455	0.045	0.367	-0.114	0.35	0.108	0.02
Trade with Australia as a share of GDP	129	124	118	129	0.109	-0.025	-0.092	-0.113	-0.17	-0.228
Home Nation Capital Flow	128	123	117	128	128	0.553	0.126	0.196	-0.091	-0.2
Home Nation Capital Stock	129	124	118	129	128	129	-0.272	0.424	-0.19	-0.352
GDP per capita relative to Aust GDP per capita	132	127	121	129	128	129	132	-0.186	0.008	0.01
Experience in Australia	132	127	121	129	128	129	132	132	-0.125	-0.194
Dummy Canada	132	127	121	129	128	129	132	132	132	-0.027
Dummy Germany	132	127	121	129	128	129	132	132	132	132
Dummy Hong Kong	132	127	121	129	128	129	132	132	132	132
Dummy Japan	132	127	121	129	128	129	132	132	132	132
Dummy Jordan	132	127	121	129	128	129	132	132	132	132
Dummy Singapore	132	127	121	129	128	129	132	132	132	132
Dummy Switzerland	132	127	121	129	128	129	132	132	132	132
Dummy UK	132	127	121	129	128	129	132	132	132	132
Dummy US	132	127	121	129	128	129	132	132	132	132
Dummy English Language	132	127	121	129	128	129	132	132	132	132
Dummy Bank WA	132	127	121	129	128	129	132	132	132	132
Dummy ING	132	127	121	129	128	129	132	132	132	132

	Dummy Hong Kong	Dummy Japan	Dummy Jordan	Dummy Singapore	Dummy Switzerland	Dummy UK	Dummy US	Dummy English Language	Dummy Bank WA	Dummy ING
Efficiency Model 1	-0.026	0.194	0.053	0.069	-0.274	0.281	-0.507	-0.16	0.192	-0.109
Efficiency Model 1a	-0.084	-0.096	0.129	0.06	-0.207	0.203	-0.227	0.028	0.251	-0.011
Efficiency Model 1b	0.037	0.181	-0.13	0.109	-0.249	0.224	-0.394	-0.109	0.226	-0.122
Efficiency Model 2	0	-0.025	0.08	0	0.036	0.086	0.037	0.086	0.16	-0.343
Home Return on Assets	-0.024	-0.39	0.098	0.179	0.337	0.07	0.074	0.128	0.091	0.157
Home Nation Investment Income	0.015	0.083	0	0.047	0.039	-0.129	-0.029	-0.137	-0.331	0.008
Log (Relative GDP per capita)	-0.103	0.438	-0.829	-0.194	0.125	-0.236	0.162	-0.084	-0.038	0.009
Competitor Market Share	-0.132	-0.015	0.094	-0.135	0.217	0.114	-0.041	0.034	0.316	0.118
Ranked Home Credit Rating	0	-0.173	0.199	-0.056	0	-0.031	0.41	0.308	-0.006	-0.08
Log (Home Assets) (Avg. Annual Ex. Rate)	-0.069	0.563	-0.271	-0.475	-0.385	-0.114	-0.044	-0.16	-0.012	0.216
Log (Home Capital) (Avg. Annual Ex. Rate)	-0.032	0.487	-0.253	0.086	-0.333	-0.347	0.011	-0.32	-0.088	0.139
Home Net Interest Margin	0	-0.68	-0.004	-0.113	0.017	0.363	0.315	0.668	-0.032	-0.133
Trade with Australia as a share of GDP	-0.107	0.76	0	-0.249	-0.227	-0.613	0.319	-0.344	-0.211	-0.176
Home Nation Capital Flow	-0.08	-0.142	0	-0.224	-0.126	0.095	0.297	0.333	0.26	0.173
Home Nation Capital Stock	-0.147	-0.37	0	-0.365	-0.22	0.493	0.384	0.765	0.384	-0.121
GDP per capita relative to Aust GDP per capita	-0.029	-0.103	-0.01	0.592	-0.064	-0.161	0.022	-0.131	-0.067	-0.015
Experience in Australia	-0.085	-0.252	-0.059	-0.173	0.122	0.246	0.199	0.376	-0.241	-0.007
Dummy Canada	-0.011	-0.073	-0.019	-0.027	-0.019	-0.085	-0.072	0.105	-0.032	-0.015
Dummy Germany	-0.019	-0.129	-0.033	-0.048	-0.033	-0.149	-0.126	-0.258	-0.055	-0.027
Dummy Hong Kong	132	-0.051	-0.013	-0.019	-0.013	-0.06	-0.05	-0.103	-0.022	-0.011
Dummy Japan	132	132	-0.09	-0.129	-0.09	-0.402	-0.34	-0.697	-0.15	-0.073
Dummy Jordan	132	132	132	-0.033	-0.023	-0.104	-0.088	-0.18	-0.039	-0.019
Dummy Singapore	132	132	132	132	-0.033	-0.149	-0.126	-0.258	-0.055	-0.027
Dummy Switzerland	132	132	132	132	132	-0.104	-0.088	-0.18	-0.039	-0.019
Dummy UK	132	132	132	132	132	132	-0.394	0.577	0.372	-0.085
Dummy US	132	132	132	132	132	132	132	0.488	-0.147	-0.072
Dummy English Language	132	132	132	132	132	132	132	132	0.215	-0.147
Dummy Bank WA	132	132	132	132	132	132	132	132	132	-0.032
Dummy ING	132	132	132	132	132	132	132	132	132	132

Note: the Australian Bureau of Statistics uses the IMF's Balance of Payments convention in which income payments abroad are shown with a negative sign, a positive sign on investment income would thus indicate income from the home nation to Australia.

Table 6: Extreme Bounds Analysis and Robustness Tests.

Panel A: Base Model: Random Effects Estimation.

	Model 1		Model 1a		Model 1b		Model 2	
	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Constant	0.76	19.20***	1.11	13.76***	0.91	24.33***	1.02	15.02***
Dummy UK	0.13	1.71*			0.10	2.13*		
Dummy Bank WA			0.15	2.19**				
Dummy ING							-0.39	-2.22**
Home Nation Investment Income	0.03	5.24***			0.02	3.91***	-0.04	-3.94***
Home Net Interest Margin					-0.03	-2.75***		
Competitor Market Share			-0.49	-3.64***				
Home Nation Capital Stock							-0.01	-3.32***
No. Obs.		120		112		112		82
Adj.R2		0.74		0.40		0.60		0.48
Hausman test		0		0.00		0.00		0.00
F-test		11.70***		2.12***		5.07***		1.54

Model 1: Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans, (ii) off balance sheet activity.

Model 1a: Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans less housing loans, (ii) housing loans (iii) off balance sheet activity.

Model 1b Inputs: (i) employees, (ii) deposits, (iii) equity capital. Outputs: (i) loans, (ii) investments, (iii) off balance sheet activity.

Model 2: Inputs: (i) interest expenses, (ii) non-interest expenses. Outputs: (i) net interest income, (ii) non-interest income.

* = significant at the 5% level, ** = significant at the 1% level, *** = significant at the 0.1% level.

Panel B: Extreme Bounds Analysis of Base Model.

Model 1.

	Lower Extreme Value	Upper Extreme Value	Percent Significant at 5% level	Cumulative Distribution Function	Average Beta	Average Standard Deviation.
Constant	-0.637	1.426	91.353	0.991	0.748	0.111
Dummy UK	-0.548	0.504	16.561	0.903	0.133	0.094
Home nation Investment Income	-0.007	0.056	97.606	0.998	0.028	0.007

2047 iterations.

Model 1a.

	Lower Extreme Value	Upper Extreme Value	Percent Significant at 5% level	Cumulative Distribution Function	Average Beta	Average Standard Deviation.
Constant	-0.049	2.043	99.902	1.000	1.089	0.121
Dummy Bank WA	-0.794	1.680	29.897	0.912	0.154	0.120
Competitor Market Share	-1.353	0.306	94.577	0.994	-0.487	0.165

2047 iterations.

Model 1b.

	Lower Extreme Value	Upper Extreme Value	Percent Significant at 5% level	Cumulative Distribution Function	Average Beta	Average Standard Deviation.
Constant	0.109	1.498	100.000	1.000	0.907	0.081
Dummy UK	-0.288	0.288	52.091	0.958	0.096	0.052
Home Nation Investment Income	-0.006	0.036	96.263	0.995	0.015	0.005
Home Net Interest Margin	-0.068	0.029	80.033	0.975	-0.030	0.013

1793 iterations.

Model 2.

	Lower Extreme Value	Upper Extreme Value	Percent Significant at 5% level	Cumulative Distribution Function	Average Beta	Average Standard Deviation.
Constant	-1.953	1.948	84.495	0.947	0.905	0.189
Dummy ING	-1.792	0.556	45.622	0.956	-0.425	0.235
Home Nation Investment Income	-0.106	-0.016	100.000	1.000	-0.049	0.012
Home Nation Capital Stock	-0.031	0.000	99.944	0.999	-0.011	0.003

1793 iterations.

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