The Efficiency of the Commercial Banks in six Pacific Island Countries

A dissertation in partial fulfilment of the requirements for the degree of

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Research Abstract:

This thesis explores the efficiency of the commercial banks in six Pacific Island Countries (PICs): Fiji, Papua New Guinea, Samoa, Solomon Islands, Tonga, and Vanuatu over the period 2000 to 2006 using Data Envelopment Analysis (DEA). The use of DEA is justified primarily due to the small number of commercial banks operating in these small countries. This is the first detailed study of the relative efficiency and performance of banking firms in this selected group of small countries.

The dominant feature of this research is to investigate the primary prudential tools commonly used by banking supervisors in regulating the local banking system. In our understanding, this is the first effort to investigate the link between individual prudential tools and bank efficiency.

The small number of banks in this dataset further enables a structural investigation of the relative efficiency across commercial banks nationally and across countries, employs a series of explanatory variables to explain the possible sources of efficiency variation, and provides a series of practical measures to validate resulting efficiency scores from DEA. This comprehensive structural construct is also a new development in bank efficiency studies.

The key research finding is the identification of liquidity requirements as the main source of bank inefficiency. Capital requirements are not only ineffective in promoting bank efficiency but in the absence of formal liquidity requirements, they become a contributing factor for causing asset deterioration. Hence, asset quality is inversely related to bank efficiency. Scale inefficiency is unusually large compared with reported scale inefficiency in the literature and in most countries, it dominates technical inefficiency.

Finally, efficiency-based ratios should continue to supplement resulting efficiency scores, at least in the current measurement and development of bank efficiency in the context of smaller developing economies.

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Abbreviations

ABS	Accessibility to Banking Services
ACB	All Commercial Banks
ADB	Asian Development Bank
AFSPC	Association of Financial Supervisors of Pacific Countries
AGR	Asset Growth Rate
ALCO	Asset and Liability Committee
AMB	Asset Management Bank of Fiji Limited
ANZ	Australia and New Zealand Banking Group
ATM	Automatic Teller Machine
BPB	Best Practice Bank
BCC	Banker, Charnes, and Cooper DEA Model
BCP	Basel Core Principles for Effective Banking Supervision
BIS	Bank of International Settlement
BNZ	Bank of New Zealand
BOB	Bank of Baroda
BOH	Bank of Hawaii
BPNG	Bank of Papua New Guinea
BSP	Bank of South Pacific
BSPS	Banking Supervision Policy Statement
CAMEL	Cost, Asset, Management, Earnings, and Liquidity
CAR	Capital Adequacy Requirement
CBA	Commonwealth Bank of Australia
CBS	Central Bank of Samoa
CBs	Commercial Banks
CBSI	Central Bank of Solomon Islands
CBV	Central Bank of Vanuatu
CCC	Cross-Country Comparison or Common Frontier
CCR	Charnes, Cooper, and Rhodes DEA Model
CEF	Cost Efficiency Function
CFF	Cobb-Douglas Functional Form
CIR	Cost to Income Ratio
CNB	Colonial National Bank
CRR	Cash Reserve Requirement
CRS	Constant Return to Scale
DAL	Deposits Available for Loans
DEA	Data Envelopment Analysis
DFA	Distribution-free Approach
DMU	Decision Making Unit
EFA	Economic Frontier Approach
FDH	Free Disposal Hull Method
FFCR	Free Financial Capital Ratio
FFF	Fourier Flexible Functional Form
FIA	Financial Institution Act
FJD	Fijian Dollar (Local currency in Fiji)
FSAP	Financial Sector Assessment Program
GDP	Gross Domestic Product
GDS	General Disclosure Statement
GL	Gross Loans
HBB	Habib Bank Limited
HSBC	Hong Kong and Shanghai Banking Corporation
IAA	Intermediation or Asset Approach
IEX	Interest Expense

IINC	Interest Income
IMF	International Monetary Fund
INF	Inflation
KDS	Key Disclosure Statement
LAR	Liquid Asset Ratio
LFI	Licensed Financial Institution
LGR	Loan Growth Rate
MBF	Malaysian Banking Finance Limited
MBK	Maybank (PNG) Limited
MLAR	Minimum Liquid Asset Requirement
NBS	National Bank of Samoa
NBSI	National Bank of Solomon Islands
NIEX	Non-Interest Expense
NIINC	Non-Interest Income
NRBT	National Reserve Bank of Tonga
NTIC	Net Interest Income
OEA	Other Earning Assets
PCB	Pacific Commercial Bank
PEF	Profit Efficiency Function
PGK	Kina (Local currency in Papua New Guinea)
PICs	Pacific Island Countries
PNG	Papua New Guinea
PNGBC	Papua New Guinea Banking Corporation
PPP	Purchasing Power Parity
PVA	Production or Value Added Approach
Q1 to Q18	Research Questions number one to eighteen
RAMSI	Regional Assistance Mission to Solomon Islands
RBF	Reserve Bank of Fiji
RBV	Reserve Bank of Vanuatu
ROA	Return on Asset
ROE	Return on Equity
RRR	Required Reserve Ratio
SBD	Solomon Islands Dollar (Local Currency in Solomon Islands)
SBM	Slack Based Model
SCB	Samoa Commercial Bank
SEM	Super Efficiency Model
SFA	Stochastic Frontier Approach
SIBC	Solomon Islands Banking Corporation
SINPF	Solomon Islands National Provident Fund
Solomon	Solomon Islands
SRD	Statutory Reserve Deposit
TA	Total Assets
TD	Total Deposits
TDB	Tonga Development Bank
TFA	Thick Frontier Approach
TFF	Translog Functional Form
TOP	Tongan Pa’anga (Local currency in Tonga)
TR	Tripal Ratio
UCA	User Cost Approach
USD	United States Dollar
VRS	Variable Return to Scale
VUV	Vatu (Vanuatu local Currency)
WBT	Westpac Bank of Tonga
WPC	Westpac Banking Corporation

Chapter 1: Introduction

"God, grant me the serenity to accept the things I cannot change, courage to change the things I can and the wisdom to know the difference"

Reinhold Neibuhr (1892-1971)

The three components of this statement may be quite distinct in parts, together, they lay a strong foundation to this journey. Consequently, like any journey, certain guidelines must be incorporated to provide a focussed sense of direction throughout.

1.1 Research Mission Statement

In conducting financial research in relatively smaller jurisdictions, researchers ought to embrace the economic environment, financial settings and reality of their subjects from the very beginning right through to the conclusions. In doing so, relevance and practical contributions toward their subjects are ensured. This commitment toward a better understanding of the Pacific banking environment is made throughout the research, starting from the relevance of the research topic, the applicability of the chosen sources for the discussion of the literature, to deciding appropriate research methodology options, interpreting, and the discussion of research results. Ultimately, research conclusions could potentially contribute by proposing relevant recommendations in strengthening banking operations in the region and perhaps, how future banking research in the region can be enhanced.

1.2 Background: Pacific Region Geography

There are about 21 Pacific Island nations (excluding some Asian countries located in the western Pacific region) spreading across the Pacific Ocean, covering about one-third of the earth's surface. The region encompasses an area of over 31 million square km^2, although only 551,400 km^2 of this is land (Fairbairn et al, 1991). This dispersion poses many challenges in areas like transportation, administration, and perhaps more importantly, economic development. This leads to increasing migration from rural to urban centres, outer islands to main islands, and overseas emigration, mainly to New Zealand, Australia and the United States.

The islands are divided into three main distinct races: Melanesia, Polynesia, and Micronesia. Melanesians (5 islands) consist of Papua New Guinea (PNG), Solomon Islands (Solomon), Vanuatu, New Caledonia and Fiji. The Melanesians are by far the most populous (PNG was estimated to account for 61% and Fiji 13% of the overall population in the Pacific region in 1987), and are richer in both land and natural resources. There is also a greater cultural diversity, with over twelve hundred languages being spoken, considered to account for a quarter of the world's total (Campbell, 1989).

The Polynesian islands (8 nations) include the Cook Islands, French Polynesia, Samoa (formerly known as Western Samoa), American Samoa, Tokelau, Tonga, Tuvalu, Niue, and Wallis and Futuna. This group is relatively smaller than the Melanesian Islands, and its resource bases are considerably smaller. However, the larger groups, such as Samoa and Tonga, have adequate natural resources to achieve a comfortable existence while for the rest, scarcity of resources reduces living conditions to basic subsistence. There is a greater reliance on foreign aid and remittances from family members living overseas.

The remaining[1] Micronesian Islands (7 nations) are Kiribati, Federal States of Micronesia, Palau, Guam, Marshall Islands, Nauru, and the Northern Marianas. Like the Polynesians, these islands are small, scattered and generally resource-poor. Except for Kiribati and Nauru, all of Micronesia comes under the United States' jurisdiction.

1.3 Political Instability in the Pacific Region

Over the recent years, the Pacific region has experienced many political challenges. Fiji has gone through three coups, amid some violence in Tonga, political tensions have developed between the police and the parliament in Vanuatu, there has been a police-led coup in Solomon, and political tensions in PNG. Many offshore banking facilities in the region (Nauru, Niue, Cook Islands and Marshall Islands) have become

[1] There are some Island nations not included in this list. Irian Jaya (western half of PNG) is a province of Indonesia, Hawaii is incorporated into a part of the USA, Easter Island, Norfolk, Midway and Pitcairn are too small and are totally dependant on other larger countries.

a concern for the international community particularly in relation to tax competition and money laundering.

While political instabilities are well documented through the international media, the impact on the local financial systems has been minimally addressed. However, in 2004 both Vanuatu and Samoa went through complete IMF and World Bank financial sector assessment program (FSAP) and Fiji completed an assessment in 2006.

1.4 The Research Objectives

Literature covering the Pacific region's banking systems is minimal. Thus, the effectiveness of the banking frameworks are relatively unknown. This observation may well be dictated by the fact that these island nations are relatively small. And yet, significant reforms have taken place over the past ten years and Samoa is considered the most successful story and is known as the darling banking system of the Pacific (Scanlan, 2004). Its political stability is a notable exception in the region.

This thesis will explore the effectiveness of the commercial banks in the region and provide a platform for an assessment of the efficacy of the banking systems with respect to the overwhelming changes and reforms observed thus far. The presence of two Australian owned commercial banks (Westpac in seven island nations and ANZ in nine) provides a secondary platform to explore how their resulting efficiency in different regions may reflect the possible efficiency of the local banking systems they operate in.

Banking systems reforms are progressing at a different pace in the region. Caution and careful consideration is needed to determine what aspects of the changes are most relevant, particularly for small island nations.

1.5 Scope of the Research

For obvious reasons, all countries in the region cannot be included in the study. Therefore, the immediate consideration is how the selection process ought to be justified. In that context, there are six Pacific Island countries (PIC) chosen for this research: Tonga, Samoa, Fiji, Papua New Guinea, Solomon and Vanuatu.

This group is the most comparable in terms of population, land and natural resources. There are more similarities: for instance, local government is predominantly democratic. Fiji and Vanuatu are republics and Tonga is a constitutional monarchy. The legal orientation for the entire group is based on British common law, except in Vanuatu, which was influenced by of both the British and French. Each country has its own central bank to undertake the prudential banking supervisory role, as a separate entity from the government, though still wholly owned by government.

Finally, these six countries currently issue their own local currency. In that context, monetary policy, economic fundamentals, and effective management of liquidity and foreign reserves challenges provide a fairly similar homogeneous platform.

Table 1: General Regional Indicators

	Fiji	PNG	Samoa	Solomon	Tonga	Vanuatu
Land Area (km^2)	18,300	462,800	2,800	28,900	800	12,200
Population (2005)	846,000	5,900,000	183,300	483,000	101,900	218,000
Population Density per km^2	46.2	12.8	65.5	16.7	127.4	17.9
Commercial Bank Assets in 2005 (USD m)	1,601.6	1,729.3	221.1	126.0	164.4	495.0
Commercial Bank Assets per capita	1,893.1	293.1	1,206.2	260.9	1,613.4	2,270.6

The data for the land area and population are sourced from the Asian Development Bank and the commercial bank assets and average exchange rates are obtained from the local Central Banks. The commercial banks' assets in 2005 is the sum for all locally operated commercial banks and converted into the USD using the annual average local exchange rate. Hence, the final item is the resulting banks' asset per individual.

These figures indicate the sheer dominance of PNG in terms of land size (88%) and population (76.3%). The population density is highest for Tonga at 127.4 per km^2 and lowest for PNG at 12.8 per km^2. Fiji, Samoa, and Tonga reflect higher population density compared with the other three and may suggest that the delivery of banking services may well be less challenging to the former island nations compared to the others. The commercial bank assets per capita further highlight this notion: Fiji, Samoa, and Tonga are well ahead of PNG and Solomon with the exception of Vanuatu.

1.6 Why does Bank Efficiency Matter?

The potential end use of this line of research is very well documented in the literature and predominantly driven by the assessment of the efficacy of resource utilisation as opposed to the traditional profitability measurements commonly concluded from financial statements. Berger & Humphrey (1997) summarise the main applications of banking efficiency studies to include: informing government policymakers, addressing research issues, and improving managerial performance.

The first component generally considers the impact of regulatory policies in banking and normally compares the before and after effects of such changes in banking efficiency. The second is dedicated to compare developments in the evolution of the measurement of banking efficiency. The final part is perhaps the most important facet, as it incorporates both earlier components and focuses on managerial or banking performance.

1.6.1 Informing government policies

This generally considers the impact of regulatory policies in banking and normally compares the before and after effects of such changes in banking efficiency. More precisely, DeYoung (1998) considers this as testing the impact of regulatory change.

The current application of regulatory change in banking remains aggregated and macro oriented. This is evident in efforts to conclude the deregulation effect in banking such as Leightner & Lovell (1998), Gilbert & Wilson (1998), DeYoung et al (1998), Drake et al (2006), Kumbhakar & Wang (2007), and Fu & Heffernan (2007). Mergers, acquisitions, and competition effect are considered by English et al (1993), Siems & Clark (1997), Resti (1998), Bos & Kool (2006), and Kwan (2006).

These studies may have contributed toward the impact of regulatory change. Perhaps the more immediate consideration is the impact of the most fundamental prudential requirements in bank efficiency, a micro oriented approach. In contrast to the macro oriented approach, this seeks to explain the possible impact of individual regulatory tool on bank efficiency.

1.6.2 Address research issues

This component is perhaps the most daunting task for researchers. Therefore, it will be discussed in more detail later. However, Berger & Humphrey (1997) note that the progress in bank efficiency studies has been focussed on research issue such as methodology and measurement choices to include: similarity of efficiency results derived from different efficiency models; the sensitivity of efficiency results due to the various application of output measures used; linking efficiency to organisational structure; impact of incorporating opportunity cost and product diversifications in the analysis; the consistency among cost, profit, and production efficiency measures; and the variation of efficiency estimates over time.

Stability of inefficiency over time

One of the main drivers for this line of research is based on the perception that inefficient banks can remain inefficient over a long period of time. This argument may hint that efficiency is a possible proxy for management culture and performance. For instance, Kwan (2006) and Bauer et al (1998) find that inefficiency is highly persistent; indicating that an inefficient bank remains inefficient for a fairly long period and more alarmingly, inefficiencies precede financial crises.

On the other hand, Valverde et al (2007) provide hindsight into why average levels of measured inefficiencies do not seem to be consistently falling over time to include: could measured inefficiencies really be overstated so that actual incentives to improve efficiency are much weaker than they appear? If inefficiencies are correctly measured, are they really beyond the control of management? If neither, what may explain the persistent differences among banks?

1.6.3 Improve managerial performances

However, managerial performance is the most important of the three components. This is expected as the resulting performance of banking institutions under the hands of managements gives rise to the relevance of efficiency results for banking regulators, while lending practical support to the development of thought in measuring efficiency by researchers.

Siems & Barr (1998) argue that conventional wisdom holds that in competitive industries the strongest institutions survive and those institutions are among the most efficient and managers need to understand where they stand relative to their competitors' best practices and productivity. They also note that benchmarking can provide opportunities for significant improvements and based on new practices and paradigms.

However, Berger & Humphrey (1997) suggest that managerial performance efficiency literature for financial institutions is the least developed of the three applications. This cautionary remark not only highlights the relative importance of this section, it echoes the current challenges in this line of research and this will be discussed at length later. Similarly, Siems & Barr (1998) note that benchmarking in the service industry is far more challenging than in manufacturing because of the difficulty in measuring services and overcoming these limitations requires an innovative approach.

The previous considerations are most likely to be equally relevant to the PIC. However, additional considerations for such studies in the region should be considered. The international banking institutions: the World Bank, Bank of International Settlement (BIS), and International Monetary Fund (IMF) can consider this avenue as an additional consideration for financial assistance through lending arrangements to the region. Foreign aid donors could well consider the same pathway to justify their ongoing assistance to the region, particularly as this could well enhance more opportunities for deepening investment and economic development.

1.7 Justification for the Efficiency of Banking in the Region

The justification for this study is based on the notion that efficient banking institutions lead to an expectation of increasing profitability, greater funds to be intermediated, better services and lower prices for consumers, promoting greater stability, while simultaneously improving more stringent capital buffers and absorbing risks (Berger et al (1993a)) or simply an indicator of success (Wheelock & Wilson (1995). Similarly, bank efficiency leads to narrowing net interest margin, enhancing investment activity and stimulating economic growth, increases consumer surpluses, as lower credit rates entail a decreasing debt service burden, and higher deposit rates leading to rising financial wealth (Hollo & Nagy 2006).

Secondly, efficiency measures should ideally be most relevant and embraced during economic contraction, where systemic declining profits are common. Bank managements need an alternative measure to provide a better picture of the welfare of banking firms relative to their counterparts. Thus, efficiency should be management's best friend in its time of greatest need, as opposed to traditional financial ratios, considered to be managements' fair weather friends.

Thirdly, capital requirements, asset quality, and liquidity requirements are three of the most fundamental regulatory tools for banking supervision. The impact of these regulations in bank efficiency is a primary objective to investigate in this research. This opportunity is justified by the presumption that in these six economies, economic developments are not excessively heterogenic; hence bank efficiency could be attributed to the resulting impact of these prudential requirements.

Finally, the number of commercial banks in these countries is small and presents an opportunity to expand the scope of data analysis beyond the current practice, and this would otherwise be relatively challenging had the sample been large.

1.8 Dissertation Structure

The rest of the dissertation is structured as follows. Chapter Two reviews the literature to understand the evolution and development of efficiency measurement in the banking context. Chapter Three switches toward the prudential frameworks of the six banking systems, addressing the dominant role of the Basel Committee in influencing the global mindset for banking supervision. The data and methodology is outlined in Chapter Four, followed by the results and discussions in Chapter Five. Chapter Six is the concluding chapter where the key empirical findings are presented and providing some guidance and suggestions for future researchers.

Chapter 2: Development of Bank Efficiency Measurements

This chapter is devoted to the development of efficiency measurement in banking literature. It is structured to provide a cohesive discussion starting from the general definition of efficiency as a concept (2.1), followed by the key developments in measured efficiency. Section 2.3 explains the current applications of efficiency measurement in the banking context. The key decisions to consider are presented with a focus on relevance, practicality and application to measuring efficiency in the PICs banking systems (2.4 – 2.7). The final section 2.8 provides a brief summary for this chapter.

2.1 General definition of efficiency

The most pivotal development in efficiency measurement is credited to Farrell (1957) based on an earlier work by Debreu (1951). Debreu introduced the coefficient of resource allocation as a measure of the efficiency of the economy. A key feature of Debreu and Farrell's coefficient is that the range of efficiency starting at 0 to 1 inclusively. The lower end reflects low inefficiency level and the upper end signals the desired outcome of higher efficiency.

Farrell's contribution is somewhat similar to the coefficient of efficiency developed by Debreu but brings forth the importance of the efficiency of a firm as a measurement of productive efficiency, specifically how far a given firm or an industry can be expected to increase output by simply improving efficiency. This effort provides the strong platform for the development of measuring efficiency. Two main features of efficiency come out of this work: measurement of efficiency should consider all the necessary range of inputs and spell the end to the common practice of using partial productivity or indices of efficiency as a measure of the overall efficiency. The efficiency of a firm is conceptualised as:

"…its success in producing as many outputs as possible from a given set of inputs, provided that both inputs and outputs are correctly measured (p. 254)".

This quotation clearly spells out the three main challenges for measuring efficiency: transformation process of input resources into outputs, identification of both inputs and outputs, and the accuracy of measuring both input and output units.

The first challenge is based on the notion that the most efficient transformation process or frontier is unknown. Therefore, the most immediate focus is to quantify and construct a proxy of this efficient frontier which, in turn, allows for efficiency to be measured. Consequently, the choice is determined by answering the question whether the efficient production frontier should be derived from a theoretical function or an empirical function. Efficiency from the theoretical function is also known as absolute efficiency, whereas the empirical function is considered as a relative efficiency. Farrell suggests that the theoretical function such as in an engineering sense (like a machine or a single process), in which perfect efficiency represents the best that is theoretically attainable, whereas the empirical function is based on best results observed in practice and is usually applied to more complicated production processes such as manufacturing. Also, the more complex the process is the more likely the theoretical function becomes less accurate.

The second challenge arises in conjunction with the first and raises the issue between price efficiency or economic efficiency and technical efficiency. Farrell argues that the former measures a firm's success in choosing an optimal set of inputs while the latter focuses on the success in producing maximum output from a given set of inputs. Also, price efficiency measures the extent of a firm's adaptation to a particular set of prices and therefore provides a good measure of its efficiency in adapting to factor prices only in a static environment. Consequently, Farrell considers this measure as unstable as these prices don't move simultaneously, dubious of interpretation, and leaving technical efficiency as a relatively uncomplicated measure. Hence, technical reflects the quality of its inputs and yet it is impossible to measure the efficiency of a firm's management entirely separately from this factor.

The third challenge, in regards to the accuracy of measuring inputs and outputs units are assumed away so far but, as we shall see later, it becomes a dominant factor in the development of the parametric approaches through the inclusion of random error to account for some of the deviations from the efficient frontier.

Figure 1: Farrell's (1957) simple case of Efficiency diagram.

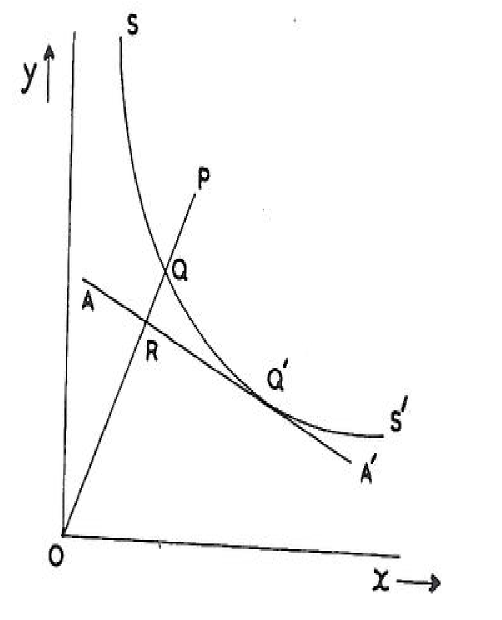


DIAGRAM 1.

Point ***P*** represents the two factor inputs (inputs x and y) per unit of output. The isoquant ***SS′*** represents the various combinations of the two factors that a perfectly efficient firm uses to produce a single output. Point ***Q*** represents an efficient firm using the same ratio of ***P****'s* resources to produce a single output using only a fraction (*OQ/OP*) of resources. Thus *OQ/OP* is the technical efficiency of firm ***P*** and this ratio ranges from 0 to 100% for a perfectly efficient firm.

In formalising the definition of a 100% efficient firm, Charnes & Cooper (1985) argue that this occurs when:

"none of its outputs can be increased without either increasing one or more of its inputs or decreasing some of its other outputs; or none of its inputs can be decreased without either decreasing its outputs or increasing some of its other inputs (p.72)."

Thus efficiency occurs when Pareto optimality is obtained and the Pareto-efficient function should be ***isotone*** or order preserving. This implies that an increase in an input should not decrease the outputs. This condition is always expected from a single output situation. In multiple output situations, this property may weaken to a ***c-d-isotone or cone-directional-isotone***, a cone direction in output space where the output projection is isotone. This property of efficiency is also known as the Pareto-Koopmans definition of efficiency (Cooper et al, 2006).

So far, the development and focus of efficiency is maximising the utilization and allocation of input resources through the transformation process into output. The next phase goes beyond the allocative efficiency mindset into a new platform, the x-efficiency generation.

Leibenstein (1966) suggests that microeconomic theory focuses on allocative efficiency to the exclusion of other types of efficiencies that are more significant and an improvement in non-allocative efficiency is an important aspect of growth. Also, x-efficiency as a concept is presented as the non-allocative efficiency component or the undefined type of efficiency. This argument is driven by empirical results suggesting that welfare gains from increasing allocative efficiency are exceedingly small (at around 1%). Furthermore, a major element of x-efficiency is motivation and it can be considered as motivation efficiency or incentive efficiency.

The essence of this development is a paradigm shift from resource allocation and utilisation of input resources alone to a more enhanced and improving level of output (and efficiency) based on the positive impact of superior managerial practices and its psychological effect on the transformation process.

2.2 Efficiency in banking

The development of efficiency measurement in banking is less convincing and possibly problematic. Research efforts have placed more emphasis on the evolution of efficiency measurement (data analysis driven) and little consideration is dedicated to the uniqueness of the banking industry and the highly regulated framework its operation is subjected to. Consequently, questions remain about its practical relevance.

For instance, Berger & Mester (1997) note that many studies have found that inefficiencies in banking are quite large, at around 20% of total banking industry costs and about half of the industry's potential profits. More alarmingly, there is no consensus on the sources of the bank efficiency. Consequently, sources of differences in efficiency across financial institutions are concealed from view within an opaque ***"black box"*** because the individual studies simultaneously differ from each another in so many different dimensions (p. 896).

A recent attempt by Valverde et al (2007) aimed to unveil the mystery of the elusive black box. They consider inefficiency associated with bank operating expenses separately from inefficiencies in funding costs. Cost differences among banks are then separated into their external, technical (cost function), and internal sources each with a different set of explanatory variables. As a result, they argue that main sources of inefficiency are largely identified. The effort provided by these authors may have been successful in explaining away efficiency variation and yet provides little guidance towards unveiling of the elusive black box phenomenon. However, it is interesting to note that the cost differences are almost identical to Leibenstein (1966) three sources of x-efficiency: internal motivation, external motivation, and non-market input efficiency.

Finally, how could the elusive black box be really de-mystified? It is evident that banking research efforts should develop more consensually accepted procedures based on a solidly justified foundation to reduce this black box phenomenon. Alternatively, resulting efficiency from banking studies will continue to echo the legendary Hanging Gardens of Babylon: so aesthetically exotic and yet unnervingly defying the universally accepted forces and law of gravity.

Typically, could we suggest that perhaps, certain efficiency measurement approaches should be practiced only when the economic conditions are favourable, strong competition and financial deepening are ensured, as in developed countries? Alternatively, could certain approaches be used when economic conditions are not extensive, banking competition is relatively weak, as expected from small and possibly developing economies? The essence of this proposition is the development of an agreed set of guidelines in which certain efficiency approaches should be applied so that variations in measured efficiency become more comparable.

2.2.1 Financial ratios

It is still common practice for banking firms to disclose an efficiency ratio or expense ratio in their financial statements. While this simple ratio may well serve its purpose alongside profitability measures, it is for this very reason that Farrell (1957) pressed the trigger (in using ratio and indexes of efficiency) in the evolution of current approaches to measuring efficiency.

Similarly, Sherman & Gold (1985) suggest that commonly used performance ratios fail to consider the multiple outputs provided with multiple inputs in banking. For instance, a bank branch which is measured as having lower profits may not be performing less technically efficient than the more profitable branches. Thus, traditional profit measures lack the capacity to evaluate how efficiently banking resources are being used in providing services.

The development from simple efficiency ratios into multiple input and output measurements is the justification for the current measurement approaches of efficiency. For instance, Bauer et al (1998) argue that frontier efficiency is superior to the standard financial ratios as it uses statistical techniques to try and remove the effects in prices and other exogenous market factors, hence obtaining better estimates of managerial performances.

Consequently, efficiency measurement approaches should provide a fundamentally reliable measure to supplement the traditional profitability measures. Bear in mind, that profitability measures have been known to fall prey to a wide range of inaccurate reporting or window dressing.

2.2.2 Scale and scope efficiencies

The application of these two concepts in banking studies has been considered by many authors as a potential source of efficiency but in a slightly varied form. For instance, Chen et al (2005) suggest that efficiency is generally classified into three forms: scale efficiency, scope efficiency, and x-efficiency.

Another variation of this by Allen & Rai (1996) suggesting that operational efficiency in banking studies is divided into two main forms: (1) optimisation of the output mix to exploit any economies of scale and scope; (2) optimisation of the input mix to avoid both excessive levels of input usage (technical x-inefficiency) and non-optimal relative proportions input (allocative x-efficiency).

The potential impacts of the economies of scale and scope have been considered to be relatively less compared to x-efficiency. For instance, Bauer et al (1998) point out that x-inefficiency of banking firms consume a considerable portion of costs on average and a greater source of inefficiencies than either scale or product mix inefficiencies, and have a strong empirical association with higher probabilities of financial institution failures over several years following the identification of significant inefficiency.

Berger et al (1993a) suggest that the literature on scope efficiency in banking is more problematic than the scale literature. This argument signals a bank-specific phenomenon that has not been explored by the literature in relation to the efficiency of banking firms: the role of the banking supervisors and the prudential framework banking firms are subjected to.

Generally speaking, economies of scale are associated with declining average costs, as output increases. In the banking context, increasing output is normally associated with increasing the loan portfolio and is subjected to the capital adequacy requirements (CAR). As such, banking firms can not issue loans at will, even if there are lending opportunities readily available to them. The current level of equity in conjunction with the risks associated with assets (both existing assets and proposed opportunity) through the CAR framework dictates the remaining volume of additional loan to be extended. While this prudential requirement is the most commonly practiced tool of banking supervision, supervisory penalties for breaching the CAR also varies across countries.

Similarly, economies of scope in banking are also regulated by banking supervisors through the permission to engage in non-traditional banking activities. Such activities include investment banking, underwriting insurance, share trading and so forth which are considered to be outside the traditional role of banking such as receiving deposits and issuing loans. Once again, this requirement varies in the scope of permissible activities as well as the degree of engagement. This prudential requirement gives rise to the concept of universal banking and separated banking. The former reflects greater flexibility in both allowing engaging and the degree of engagement in non-traditional banking activities, while the latter is more restrictive.

The importance of this prudential requirement is highlighted by the US government recent proposal to strengthen its banking sector following the 2008 crisis by focussing on the need to redress and change its current prudential position. The 1933 Glass-Steagal Act that separated commercial and investment banking was repealed by the Gramm-Leach-Bliley Act of 1999. The proposal is to revert back to the separation, limiting the commercial banks from engaging in underwriting investment banking activities.

Finally, Berger et al (1993a) point out that x-efficiencies account for about 20% of costs in banking, while scale and product mix inefficiencies are about 5% when accurately estimated. Berger et al (1993b) find input x-inefficiencies far outweigh that of the output inefficiencies (as measure by economies and diseconomies of scope) among international banks. This finding suggests that greater emphasis in banking efficiency research should be directed towards x-inefficiencies (technical and allocative) as oppose to scale and scope inefficiencies.

2.2.3 X-efficiency

The introduction of x-efficiency studies emerges around the 1960s; published technical research on its application to financial institutions has only appeared around the early 1990s and predominantly focussed on the US commercial banks only (Berger et al, 1993a). It is now commonly practiced worldwide. Leibenstein (1966) initially referred to x-efficiency as the undefined type of efficiency, improvements in x-efficiency is a significant source of increased output, and its three significant determinants are: internal motivational efficiency, external motivational efficiency, and non market input efficiency.

X-efficiency is defined as the ratio of the minimum costs that could have been expended to produce a given output bundle to the actual costs, and range between 0 – 100%. It includes both technical inefficiency or errors that result in general overuse of inputs, and allocative inefficiency, or errors in choosing an input mix that is consistent with relative prices (Berger, 1993).

Technical efficiency measures whether the firm is maximising production from available resources (Altunbas & Chakravarty, 1998) or failure to produce maximum output given the set of inputs used (Schmidt & Sickles, 1984). Allocative efficiency measures whether the best combination of inputs is being used in relation to their relative cost (Berger et al, 1993a).

2.3 Approaches to measuring banks' efficiency

Berger & Humphrey (1997) identify five different approaches to determining the efficient frontier: three parametric approaches (Stochastic Frontier Approach (SFA), Distribution-free Approach (DFA), and Thick Frontier Approach (TFA)) and two non-parametric approaches (Data Envelopment Analysis (DEA) and Free Disposal Hull Method (FDH)).

The key distinction between the approaches is that each parametric approach has different ways of dealing with random error and the non-parametric approaches fail to account for random error. Similarly, these approaches (Bauer et al, 1998) differ in the assumptions they make regarding the shape of the efficient frontier, the existence of random error, and (if random error is allowed) the distributional assumptions imposed on the inefficiencies or random error in order to disentangle one from the other. They also a distinction whether the underlying concept analysed is technological efficiency versus economic efficiency, in those parametric studies usually measure economic efficiency and nonparametric studies measure technological efficiency.

The literature fails to agree on the issue of when and how to make a choice from any of these approaches. As such, all five approaches are briefly discussed to provide a foundation regarding which approach is most suitable to this study.

2.3.1 Parametric approaches: Stochastic Frontier Approach (SFA)

SFA is also known as the economic frontier approach (EFA). It was independently developed by Aigner, Lovell & Schmidt (1977) and Meeusen & van den Broeck (1977). It attempts to decompose the residual of the frontier into efficiency and noise by making explicit assumptions about the efficiency component's distribution.

Aigner et al (1977) note that only since the pioneering work by Farrell (1957) that serious consideration has been given to the possibility of estimating frontier production functions to bridge the gap between theory and empirical work. Also, at that stage, a couple of problems had not been accounted for such as the extreme sensitivity to outliers and reconciling the observations above the frontier considering the concept of the production frontier as the possible maximum output level. This study led to the specification of the error term as being made up of two components ($\boldsymbol{\varepsilon_{it} = v_{it} + u_{it}}$) one normal and the other from a one-sided distribution. An example of an economic justification for this approach is that a farmer whose crop is decimated by drought or storm is unlucky but considered inefficient by the standard measure. Thus, it seems preferable to incorporate the possibility of measurement error, and of other unobservable shocks in a less arbitrary fashion.

Similarly, Meeusen & van den Broeck (1977) arrived at a similar conclusion by considering the difference between the standard Cobb-Douglas model and a composed error model. In their account of the frontier production function, one disturbance is due to inefficiency and a statistical disturbance due to data randomness is caused by misspecification and measurement errors. The separation of the error component into two distinct components and the distribution of both are similar to that found by Aigner et al (1977).

2.3.1.1 Definitions and Assumptions

The three main features of this approach are in relation to the specification of the efficient functional form, distribution of efficiency, and the distribution of random error.

The functional form requirement normally associates with the specification of a functional form and most commonly the cost frontier functional form and in some cases the profit functional form. This functional form reflects the production relationships between inputs, outputs, and in some cases environmental factors (Berger & Humphrey, 1997).

Once the functional form is constructed, the deviations from the frontier form the remaining two components: the inefficient component and the random error component. The error term component represents random deviations from the frontier, is assumed to be drawn from a two sided distribution and such random fluctuations follow a symmetric normal distribution. This underlying assumption is based on the notion that either inputs or outputs or both may have been inaccurately measured. The second component, inefficiencies, is drawn from a one sided distribution and commonly assumed to follow an asymmetric half-normal distribution. In case of a cost functional form, it is justified since inefficiency raises costs (Mester, 1993). This half-normal assumption on the inefficiencies is inflexible relative to other distributions such as the gamma and it embodies the arbitrary restriction that most firms are clustered near full efficiency (Berger, 1993).

Similarly, Bauer et al (1998) note that this approach employs a composed error model: where both inefficiencies and random errors are calculated. The error term from the cost function is given by $\boldsymbol{\varepsilon} = \boldsymbol{\mu} + \boldsymbol{v}$, where $\boldsymbol{\mu} \geq 0$ representing inefficiency as the half normal distribution cannot be subtracted from costs and that most firms are clustered near efficiency, and so it must be drawn from a truncated distribution and $\boldsymbol{v}$ represents random error and behaving according to a normal distribution. Both inefficiencies and random errors are assumed to be orthogonal (related to or perpendicular) to the input prices, output quantities, and any other cost function regressors specified. The efficiency of each firm is based on the conditional mean (or mode) of inefficiency term $\boldsymbol{\mu}$, given the residual which is an estimate of the composed error term.

Procedures for SFA (Bonin et al (2005))

Step 1: Estimate the minimum cost or maximum profit frontier from the entire sample.

Step 2: Total cost (TC_{it}) for *ith* bank, in the year *t*, Y_{it} represents the various products or services produced by the firm, P_{it} represents the prices of inputs. The random disturbance has two components: v_{it} is the measurement error (or controllable factor) and the uncontrollable factor, u_{it} is technical and allocative efficiency and is influenced by management.

$$TC_{it} = f\ (Y_{it}, P_{it}) + v_{it} + u_{it} \text{ where } \varepsilon_{it} = v_{it} + u_{it}$$

Step 3: Use a translog specification for the cost function with the standard symmetry and homogeneity assumptions.

Step 4: Total profit (TP_{it}) similar to the TC_{it} function except the random disturbance components are not added but subtracted.

$$TP_{it} = f\ (Y_{it}, P_{it}) + v_{it} - u_{it}$$

The $\mathbf{v_{it}}$ term is the random error, assumed to be identically distributed as normal variates with zero mean and variance equal to $\boldsymbol{\sigma^2_v}$ and $\mathbf{u_{it}}$ are nonnegative random variables distributed normally but truncated (cut-off) below zero, $\mathbf{N(0, \sigma^2_v)}$. The $\mathbf{u_{it}}$ term or technical inefficiency is assumed to follow a half normal distribution in which both mean and variance may vary, $\mathbf{|\ N(0, \sigma^2_u)\ |}$. TC is the sum of interest and non-interest costs. Y_{it} are total deposits, total loans, total liquid assets and investments other than loans and liquid assets. P_{it} includes prices of capital and the price of funds. The TC function is replaced by the TP as total profit and RHS stays the same, equals to the net profit for each bank. A constant is added to all banks to avoid having negative TP, enabling to take logarithms for all variables.

2.3.1.2 SFA strengths

Bauer et al (1998) note that the SFA always ranks the efficiencies of the firms in the same order as their cost function residuals, no matter which specific distributional assumptions are used. In that, firms with lower costs for a given set of input prices, output quantities will always be ranked as more efficient because the conditional mean or mode of inefficiency (given the estimate of the residuals) is always increasing in the size of the residuals. They also note that this property has intuitive appeal for a measure of performance for regulatory purposes, as a firm is measured as high in the efficiency rankings if it keeps costs relatively low for its given exogenous conditions.

2.3.1.3 SFA weaknesses

Bauer et al (1998) argue that the half normal distributional assumption on inefficiencies is also based on the assumption that most firms are clustered near efficiency, but there is no theoretical reason why inefficiencies could be more evenly distributed, or close to symmetrically as for random error. Greene (2005) takes this even further to question whether inefficiency is a fixed effect or random effect while Battese & Coelli (1995) incorporate a time element into the inefficiency component. Some studies such as Bauer & Hancock (1993) and Berger (1993) using DFA which imposes no shape on the distribution of inefficiencies have suggested that inefficiencies behave more like symmetrical normal distribution than half-normal. Berger & Mester (1997) suggest that if panel data are available, some of these maintained distributional assumptions can be relaxed and the DFA can be used instead.

Efficiency results depend critically on the skewness of the data, any inefficiency components that are more or less symmetrically distributed tend to be measured as random error and any random error components that are more or less asymmetrical distributed tend to be measured as inefficiency (Berger (1993) and Allen & Rai (1996)). An additional problem with parametric methods is that even if the functional form is correctly specified, there is typically a non-trivial probability of drawing samples with the *wrong skewness* (Simar & Wilson, 2007).

Under the common frontier assumption, relative bank efficiency may be influenced by other factors not generally incorporated in the efficiency analysis, such as the differences in the type of bank business conducts, markets its operates in, and differences in the economic climate (Bos & Kool, 2006). This concern is more prominent in cross-country comparisons of bank efficiency (Berger et al, 1993a) leading to subsequent studies incorporating country-specific environmental conditions (Dietsch & Vivas, 2000) such as regulatory, demographic and economic conditions.

Despite the efforts of the above authors, one key question that is yet to be addressed: what is the expected sample size for the dataset? While this issue is not clearly spelled out, the distributional assumption for the random error component statistically assumes that the dataset should be fairly large.

2.3.2 Parametric approaches: Distribution-free Approach (DFA)

DFA was introduced by Berger (1993) based on an earlier panel data approaches developed by Schmidt & Sickles (1984). It was developed on the SFA logic but distinguished by not applying assumptions to the distribution of the efficiency component (Hollo & Nagy, 2006).

2.3.2.1 Definitions and Assumptions

Efficiencies are stable over time while random error tends to average out (Schmidt & Sickles, 1984). It is considered in a sense that little in the way of shape is imposed on the distributions of efficiency or random error. Berger's (1993) justifications for these assumptions are that cost differences owing to x-efficiencies are persistent, while random errors tend to average out over time. In that, good management maximises long-run profits by keeping costs relatively low over long period of time, although costs may fluctuate from this trend because of luck and measurement error.

Similarly, the estimated inefficiency for each firm in a panel data set is the difference between its average residual and the average residual of the firm on the frontier and some truncation performed to account for the failure of random error to completely average out to zero (Berger & Humphrey, 1997).

In a comparison of the DFA, SFA, and TFA, Bauer et al (1998) note that DFA specifies a functional form for the cost function, as does SFA and TFA but DFA does not impose a specific shape on the distribution of efficiency (as does SFA), nor suggests that deviations within one group of firms are all random error and deviations between groups are all inefficiencies (as does TFA). Instead, it assumes that there is core efficiency for each firm which is constant over time, and random error tends to average out over time and a panel data set is required, and only panel estimates of efficiency over the entire time interval are available.

Procedure for DFA (DeYoung (1997, p. 244))

Step 1: Use a time series (t = 1, 2, …T) and cross section (***i*** = 1, 2, …, N) panel data in which each bank (***i***) is represented in each year.

Step 2: Estimating the cost function: $\ln C_{it} = \ln f\,(Y_{it}, P_{it}) + \ln x_i + \ln v_{it}$
C=total expenses, $f(\ )$ = cost function, Y = vector of outputs, P = vector of input prices, x_i = bank specific x-efficiency factor, and v_{it} = random error term. The ln x and ln v are treated as the composite error terms: $\ln \boldsymbol{\varepsilon_{it}} = \mathbf{\ln x_i + \ln v_{it}}$

Step 3: Once the estimates are completed, these residuals are averaged across T years for each bank. The averaged residuals are estimates of X-efficiency terms $\mathbf{\ln x_i}$ because the random error terms $\mathbf{\ln v_{it}}$ tend to cancel each other out in the averaging.

Step 4: The distribution-free estimator for each bank is as follows:

$$\text{dfe}_i = \frac{1}{T}\sum_{t=1}^{T} \ln\ \varepsilon_{it} = \ln \breve{x}_i$$

T= number of annual observations in the time series across data set.

Step 5: dfe_i (T) is rescaled as a percentage of the X-efficiency of the most efficient bank: $\text{X-EFF}_i\,(T) = \exp\,[\text{dfe}_{min}\,(T) - \text{dfe}_i\,(T)]$

The dfe_m (T) is the minimum value of dfe_i (T) over all banks. For each bank X-EFF_i (T) increases with cost efficiency, is nonnegative and has an upper bound of one, and is used to neutralise the impact of statistical outliers.

2.3.2.2 Strengths of DFA

Bauer et al (1998) suggest that DFA is intuitively appealing as a measure of economic performance because it is based on keeping costs low for a given set of outputs and input prices over a period of time and many changes in economic conditions.

DeYoung (1997) argues that the statistical assumptions are intuitive and easy to apply. This approach is also enhanced when he attempts to identify an appropriate value for number of observations, just enough to capture the bulk of the averaging out effects but small enough to limit the distortions caused by the intertemporal shift. To pinpoint a better solution for this problem, he used a diagnostic test in a DFA cost efficiency model, using 11 years data from US commercial banks, and found that six years is adequate to be reasonably sure that estimated X-efficiency contains only small amounts of random error. Using eight or more years may violate the DFA assumption that bank level inefficiency remains constant over time. However, DeYoung notes that these results may differ greatly for other industries or for models that employ different efficiency concepts, economic specifications, or functional forms.

Perhaps the credibility of this approach is based on its assumption regarding the stability of efficiency. In that, it promotes a notion that the efficiency of a banking firm signals the culture of banking business for each institution. Should that perception be remotely acceptable then the efficiency of banking firms could well proxy the culture of banking operations.

2.3.2.3 Weaknesses of DFA

While the fundamental assumption of the DFA suggests the stability of efficiency over time, it may well fall short when the event leading to a potential shift in operation eventuates. One such example is considered by Berger (1993) as the replacement of managers or internal restructuring. In addition to this scenario, significant changes to the banking supervisory framework and major shifts in economic conditions may force management to re-evaluate the nature of their banking operation.

DeYoung (1997) argues that a critical experimental design consideration in this approach is determining the number of annual observations to include in the observation, too few years may leave a large amount of random error in the average residuals, while including too many years may violate the assumption of constant x-efficiency. Either case, the resulting estimates for x-efficiency will be less accurate and bank efficiency comparisons will be misleading.

Bauer et al (1998) note that there is concern that the levels of DFA efficiency estimates may be influenced by its assumptions, such as the measurement of core efficiency, meaning that efficiency variations over time for an individual firm tend to be averaged out with the random error. They also suggest that DFA's implicitly assumes that inefficiency is the only time-invariant fixed effect and if there are other factors which are persistently affecting a firm's cost that are not included in the regression model, such as high-crime location, this may not be counted as inefficiency, although this would affect all other frontier approaches as well.

2.3.3. Parametric approaches: Thick Frontier Approach (TFA)

TFA was developed by Berger & Humphrey (1991) and is generally used for regulatory conclusions due to the highly dispersed nature of banking data, and it requires assumptions only allowing the estimation of mean efficiency scores.

2.3.3.1 Definitions and Assumptions

The TFA approach specifies a functional form and assumes that deviations from predicted performance values within the highest and lowest performance quartiles of observations represent random error, while the difference between the highest and lowest predicted performance quartiles represent inefficiencies (Berger & Humphrey, 1997). This approach has no distribution assumption on either inefficiency or random error except an assumption that inefficiencies differ between highest and lowest quartiles and that random error exist within these quartiles. TFA does not provide point estimates of efficiency for individual firms, instead, providing an estimate of the general level of overall efficiency.

Bauer et al (1998) suggest that TFA measurement of inefficiencies are embedded in the difference in predicted costs between the lowest and highest cost quartiles, and this difference may occur in either the intercepts or slope of the parameters.

Schure et al (2004) employed a recent development of the TFA or the new recursive thick frontier approach (RTFA), based on their earlier effort in 2001. RTFA is an economic frontier approach in assessing technical efficiency that relies on an iterative procedure and proven to be superior to the SFA in panel datasets, especially when efficiency levels change over time.

Procedure for TFA (Vivas (1997, p. 385))

Step 1: A translog profit function is specified and estimated for the entire data. The profit function is estimated jointly with cost and profit equations.

Step 2: The set of “best-practice banks (BPB)” are identified and are represented by the quartile of firms that experienced the highest average profitability over the period.

Step 3: Using the entire data set, a dummy variable is specified to separate the BPB and their own second-order and cross-product parameters in the profit function. The dummy variable allows the thick frontier to be estimated using all observations rather than just a quartile subset.

Step 4: This selection and estimation procedure is repeated using the quartile of banks that experienced the “worst-practice” profitability over the period. The efficiency results are all reestimated using the subset of observations on the best-practice and worst-practice quartiles separately, rather than the dummy variable.

Step 5: Considering the variation in size for the observations, both standard and alternative profit functions are reestimated using ROA in place of profit levels.

Step 6: Measurement of the inefficiency residual to determine the unexplained difference in average bank’s profit between the most and least profitable quartiles, respectively. The total difference in profitability is the average difference in predicted profits and part of that is explained by market factors and the remaining difference is the unexplained residual is presumed to reflect inefficiency.

2.3.3.2 Strength of TFA

Mester (1996) argues that TFA is quite uncomplicated to implement and more flexible regarding statistical properties of the inefficiency measures than there is in other measures, such as SFA.

Vivas (1997) examines the stability of banks in the highest and lowest quartiles over six years (TFA uses the entire period and not on an annual basis) and finds strong evidence of a high degree of stability between the highest and lowest profit quartiles and thus persistence is reasonably satisfied. Vivas also argues that TFA can also determine how the frontier has shifted over time, and can account for error in the data and reduce the influence of outliers, and the main benefit of TFA is it ability to provide a firmer basis for determining the realizable efficiency of an industry. Also, instead of basing an efficiency estimate on one or a very small subset of firms, as the other “thin” frontier measures do, TFA selects a relatively large subset of firms to define the frontier. Consequently, measured inefficiency is smaller because it is more realistic to expect firms to be able to achieve the efficiency level already obtained by the most profitable 25% of firms than it is to expect all firms on the frontier to be as efficient as the single most profitable firm.

2.3.3.3 Weakness of TFA

Berger & Humphrey (1992) point out that these assumptions do not hold exactly and are sensitive to whether banks are divided into quartiles or quantiles or any number of groups. Further, there is the potential for econometric problems since the banks are pre-sorted using average cost, which is essentially a dependent variable.

Bauer et al (1998) note that in most applications of TFA, it only gives the estimate of efficiency differences between the best and the worst quartile to indicate the general level of overall efficiency but does not provide the point estimates of efficiency for individual firms. They also suggest that TFA levels of efficiency are based on a rather arbitrary set of assumptions, in that the lowest average-cost quartile within each size class is an adequate thick frontier of efficient firms.

2.3.4. Non-Parametric approaches: Data Envelopment Analysis (DEA)

DEA was developed by Charnes, Cooper and Rhodes (1978) to evaluate the efficiency of public sector non-profit organisations where accounting profit measures are of little value, where multiple outputs are produced with multiple inputs and where the efficient or standard input-output relationships are not easily identified. This development emerges where prices may not be available or reliable, and the assumption of cost minimising or profit maximising behaviour may not be appropriate Bauer et al (1998).

This development serves as a benchmark for the Debreu-Farrell measure of efficiency (Canhoto & Dermine (2003)) and Seiford (1996) presents a more comprehensive list of this development. Sherman & Gold (1985) were the first to apply DEA to banking. It is now the most common approach in measuring banking efficiency.

2.3.4.1 Definition and Assumptions

DEA frontier is formed as the piecewise linear combination that connects the set of best-practice observations in the dataset under analysis, yielding a convex Production Possibility Set (PPS). Consequently, DEA efficiency scores for a specific decision-making unit (DMU) are not defined by an absolute standard but relative to the other DMUs in the specific dataset under consideration (Casu & Molyneux, 2003). Cooper et al (2006) point out that the name of this approach is based on the way it envelops observations in order to identify a frontier that is used to evaluate observations representing the performance of all evaluated entities by identifying the sources and amounts of inefficiency (or waste) in each input and output for every DMU and the DMUs located on the efficient frontier.

DEA was originally developed on a constant return to scale (CRS) basis often referred to as CCR model based on the names of the three authors. It was later extended to variable returns to scale (VRS) by Banker, Charnes & Cooper (1984). It allows for the identification of whether a DMU is operating at increasing, constant, or decreasing returns to scale and commonly known as the BCC model. It also allows for the separate identification of technical and scale inefficiency. Technical efficiency is the efficiency score for the CRS model and scale efficiency requires the data to run through both CRS and VRS models, and dividing CRS score by the VRS score. Hence, scale efficiency score = CRS score/ VRS score.

Multiple outputs and inputs do not require pre-assigned weights a priori; rather it identifies a set of best performing DMUs, where efficiency scores for all DMUs are evaluated. The efficiency score reflects a series of weights as determined from the data, one for each output and one for each input that produces the highest efficiency score. These weights are called multipliers (as opposed to the traditional weighting procedures) and can be used to evaluate changes in the efficiency score for a DMU, accompanying a change in the corresponding input or output.

A reference set for an inefficient DMU is made up of the efficient DMUs which, a inefficient DMU is measured against. This reference set is the non-parametric version of the efficient frontier under the parametric approaches. In addition to the benchmarking use of the reference set for measuring efficiency, it also allows management to locate and understand the nature of inefficiencies by comparing the inefficient DMU with its corresponding efficient counterpart (Sherman & Gold, 1985).

Tone (2001) proposes the slack based measure (SBM) of efficient DMUs to incorporate simultaneous input excess and output shortfalls and consequently interpreted as the product of both input and output inefficiencies. This procedure also deals with the frequent zero allocated weights under the traditional measures by allocating weights to all inputs and outputs in all DMUs with the exception of any non-positive data. Furthermore, SBM attempts to find the maximum virtual profit as opposed to the CCR which focus on finding the maximum ratio of virtual output over virtual input.

Andersen & Petersen (1993) expand the development of DEA to further analyse and rank all efficient DMUs from previous models. Their idea compares the DMU under evaluation with a linear combination of all other efficient DMUs in the sample, thus the DMU is excluded. This led to Tone (2002) consolidating his SBM and the super-efficiency model (SEM) originated by Andersen & Petersen (1993) to obtain the slack-based measure of super-efficiency. This SEM is considered as a measure of stability, if the input data is subject to error or changes over time, and provides a means of evaluating the extent to which such changes could occur without violating that DMU's status as being an efficient unit (Cook & Seiford, 2009).

Casu & Molyneux (2003) suggest that Tobit regression model approach is used to analyse the influence of various country-specific and environmental factors on bank efficiency and it can account for truncated data, although there is some question as to the validity of this approach (Simar &Wilson, 2007). Bootstrapping[2] is also used to overcome the inherent dependency of DEA scores used in regression. Dependency is justified by the fact that DEA efficiency score is a relative efficiency index not an absolute efficiency index, thus violating the independence assumption in regression analysis and suggesting that conventional procedure is invalid (Grosskopf, 1996).

The series of assumptions under DEA based on the homogeneity of the units under assessment: firstly, units are assumed to be engaging in similar activities, producing comparable set of output and common technologies are used; secondly, similar range of resources is available to all units; thirdly, all units are operating under similar environment (Dyson et al (2001)); finally, the adequate sample size should be larger than the product of the number of inputs and outputs (Cooper et al, 2006) or the sample should be at least three times larger than the sum of the number of inputs and outputs.

Key procedures in the CCR, original DEA (Cooper et al, 2006, p. 23-25)

Step 1: Measuring the efficiency of each DMU needing ***n*** optimizations for each evaluated DMU$_j$ as a fractional programming problem.

$$\max_{\mathbf{v},\mathbf{u}} \theta = \frac{u_1 y_{1j} + \ldots + u_s y_{sj}}{v_1 x_{1j} + \ldots + v_m x_{mj}}$$

$$\text{subject to } \frac{u_1 y_{1j} + \ldots + u_s y_{sj}}{v_1 x_{1j} + \ldots + v_m x_{mj}} \leq (j = 1, \ldots, n)$$

[2] It is a computer-based method for assigning measures of accuracy to statistical estimates, introduced by Efron (1979) and Simar (1992) for computing confidence intervals for efficiency scores derived from non-parametric frontier methods (Casu & Molyneux, 2003, p. 1867)

$v_1, v_2, \ldots, v_m$ and $u_1, u_2, \ldots, u_s \geq 0$

Step 2: Replacing the fractional program with the linear program.

max $_{\mathbf{v,u}}$ $\theta = u_1 Y_1 + u_2 Y_2 + u_1 Y_1 + \ldots + u_s Y_s$

subject to $\quad v_1 X_1 + v_2 X_2 + v_1 X_1 + \ldots + v_m X_m = 1$

$u_1 Y_{1j} + u_2 Y_{2j} + \ldots + u_s Y_{sj} \leq v_1 X_{1j} + v_1 X_{1j} + \ldots + v_s X_{sj}$

$(j = 1, \ldots n)$ and $v_1, v_2, \ldots, v_m$, and $u_1, u_2, \ldots, u_s \geq 0$

Step 3: Optimal solution for the linear program

The (v*, u*) is the optimal solution for the linear program resulting in a set of optimal weights for the evaluated DMU$_j$. The evaluation is based on a ratio scale and represented by: $\theta^* = \dfrac{\sum_{r=1}^{s} u_r^* y_r}{\sum_{i=1}^{m} v_i^* x_i}$

If the denominator is 1 then $\theta^* = \sum_{r=1}^{s} u_r^* y_r$ and v_i^* is the optimal weight for the input item i and its magnitude reflects how highly the item is evaluated. Similarly, u_r^* is similar for the output item r. Thus, $v_i^* X_i$ in the input $\sum_{i=1}^{m} v_i^* y_i$ (=1) shows the relative importance of each item to the value of each $v_i^* X_i$ and similarly, for the output item.

Step 4: CCR Efficiency and Inefficiency

A DMU$_j$ is CCR-efficient if θ^* =1 and there should be at least one optimal (v*, u*) where v* > 0 and u* > 0, otherwise DMU$_j$ is CCR-inefficient. Similarly, A DMU$_j$ is CCR-inefficient if θ^* <1 or θ^* = 1 and at least one element of (v*, u*) is zero for every optimal solution from the linear program.

2.3.4.2 Strength of DEA

The obvious benefit of DEA is that it does not require the explicit or clearly expressed specification of a functional form and imposes very little structure on the shape of the efficient frontier and the data are allowed to speak for themselves (Wheelock & Wilson, 2006). It handles multiple inputs and outputs stated in different measurement units, and focuses on a best-practice frontier rather than population central tendencies (Chen et al, 2005).

Siems & Barr (1998) suggest that the DEA model could be useful to regulators as a complementary off-site monitoring tool. They also list the attributes of the DEA model to include: a solid economic and mathematical underpinning; alternative actual and composite or hypothetical best-practise units; the ability to take into account the trade offs and substitutions among the benchmark metrics; and a means to suggest directions for improvement on many organisational dimensions.

Bauer et al (1998) compare DEA, SFA, and TFA and find some evidence to indicate that there is some stability in efficiency over time, that there is little difference in the stability of efficiency between parametric and nonparametric methods. A notable difference among the techniques is that DEA methods generally show more stability than the other methods. Similarly, Sickles (2005) investigates a hosts of parametric estimators and non-parametric efficiency estimators including DEA and finds that DEA estimator is a superior estimator of technical efficiencies changing over time for firms, and also performs very well in ranking of true and estimated efficiency of firms, particularly, when the number of cross-sections and time series increase.

2.3.4.3 Weakness of DEA

Perhaps the common argument against DEA is in relation to its inability to incorporate random error. Banks that have been lucky or whose costs have been under-measured would be labelled as most efficient, any unfavourable influence beyond a bank's control would be attributed to inefficiency (Mester, 1996). Even worse, if there is random error on the efficient frontier or a dominant reference set, it affects the measured efficiency of all the firms that are compared to (Bauer et al, 1998).

DEA uses only the data on inputs and outputs and may not take direct account of input prices in which case we could not estimate allocative inefficiency (Berger, 1993). However, this concern is a contradiction with Farrell's (1957) original stand on problems arising from price efficiency.

Bauer et al (1998) note that potential problem for DEA is the issue of ***self-identifiers*** and ***near-self-identifiers***. Each firm can only be compared to other firms on the frontier with the same or more of every output (at any given level of input) or vice versa plus other constraints imposed on the basis of comparability for quality controls. Consequently, having no other firms in so many dimensions can result in firms being measured as highly efficient or self-identified as 100% efficient solely for lack of comparable firms under these constraint variables. In essence, this problem often arises when there are a small number of observations relative to the number of inputs, outputs, and other constraints resulting in a difficulty of matching up in all dimensions.

Brown (2006) points out that DEA's weakness is that it is *deterministic*[3] and plagued by measurement errors in variables. Similarly, Fried et al (2002) suggest that most DEA models and virtually all operational DEA models are deterministic, thus unable to capture the stochastic component of a DMU. This motivates these authors to develop a DEA based model that contains a stochastic element designed to isolate the impact of luck from those managerial performance and environmental impacts. Unfortunately, this line of thought is economically and statistically unsound as this deterministic feature of DEA is perhaps its strongest attribute.

2.3.5 Non-Parametric approaches: Free Disposal Hull Method (FDH)

Soleimani-damaneh et al (2006) note that FDH was first formulated by Deprins, Simar and Tulkens in 1984 and the model relies on the sole assumption that production possibilities satisfy free disposability and ensures that efficiency evaluations are affected from only actually observed performances.

2.3.5.1 Definitions and Assumptions

FDH is a special case of the DEA model where the points on lines connecting the

[3] Pastor et al (1997) argue that an efficiency model is deterministic if it does not have an error term and the presence of an error term gives rise to the stochastic models (p. 396).

DEA vertices are not included in the frontier. Its production possibilities set is composed only of the DEA vertices, and typically generate larger estimates of average efficiency than DEA (Berger & Humphrey 1997).

Leleu (2006) argues that the introduction of FDH is based on a representation of the production technology given by observed production plans, imposing strong disposability of inputs and outputs without the convexity assumption. Also, the model assumes implicitly variable to scale (VRS) and is solved by a mixed integer linear programming, and is often used to compare to DEA. Leleu proposed one step further by introducing a complete linear programming framework to deal with all previous FDH models, and this approach obtains the static decomposition of economic efficiency into technical and allocative components.

2.3.5.2 Strengths of FDH

Leleu (2006) notes that the strengths of their approach include: dealing with more sophisticated FDH models without additional costs in terms of program development as it can be readily extended to introduce constraints on input and output substitution, regulatory constraints or environmental variables; duality in linear programming can be considered a major benefit and enhancing the economic interpretation of the FDH technology in terms of shadow prices and can easily include weight restrictions or constraints on prices.

De Borger et al (1998)[4] note that FDH is very intuitive and attractive for efficiency measurement purposes, particularly in providing an attractive basis for the evaluation of different efficiency measures. Also, it imposes minimal assumptions with respect to the production technology, the conflict between the radial (ray) measure of technical efficiency and Koopman's definition of technical efficiency can be quite prominent, thus providing a good test case for examining empirical differences across radial and nonradial measures of efficiency.

[4] Theoretical advantages and disadvantages of FDH comparing to DEA are covered by Lovell & Eekaut (1994) and Tulkens (1993)

2.3.5.3 Weaknesses of FDH

Jeong & Simar (2006) note that the nonsmoothness and discontinuities of FDH are a drawback for conducting inference in finite samples and that bootstrapping of FDH has poor performances and is not useful in practice. They proposed the linearised version of the FDH and show that their results work well even in moderate sample sizes and outperforming FDH both in bias and the original FDH estimator.

De Borger et al (1998) note that FDH is not as popular because: its strong disposability assumptions preclude the detection of congestion in the technology, in contrast some DEA models can accommodate this phenomenon; the integer solutions under FDH results in a loss of contact with the duality theory of ordinary linear programming, consequently FDH offers little information regarding the underlying structure of production technology (such as opportunity costs and substitution ratios), a contrast with DEA models, which allow one to determine substitution and transformation possibilities through duality theory.

Table 2: Key Features of the five Efficiency Measurement Approaches

	FUNCTIONAL FORM	ERROR COMPONENT	EFFICIENCY
SFA	Yes	Yes*	Yes****
DFA	Yes	No**	Yes*****
TFA	Yes	Yes***	No******
DEA	No	No	Yes
FDH	No	No	Yes

* Normal Distributed, ** Average out to zero, *** Difference within highest and lowest quartile, **** Half-normal distributed, ***** Stable over time, ****** Only Industry and difference between highest and lowest quartile.

2.4 Deciding the best approach

Having discussed the five approaches for measuring banking efficiency, the next step is perhaps the most important decision for banking researchers. The literature does not provide a firm answer to this dilemma but a few authors have given some guidance.

For instance, Bauer et al (1998) suggest that despite intense research efforts, there is no consensus on the best methods or set of methods for measuring frontier efficiency, and the choice of method may affect the policy conclusions that are drawn from the analyses. They also suggest the so called "possible tie-breaker conditions" to assist in determining which method might be better, such as comparing efficiency results with reality, economic conditions, and other nonfrontier economic performance measures.

Berger et al (1993a) also address this problem and suggest there is no simple rule for determining which of these methods best describes the true nature of banking data. They argue that it would not be a problem if all of the methods arrive at essentially the same conclusion and unfortunately, this is not the case. Consequently, the choice of measurement method appears to strongly affect the level of measured inefficiency. For example SFA, DFA, and TFA methods usually find average inefficiency to be about 20-25% of costs, while DEA results range from less than 10% to over 50%.

Berger & Mester (1997) also note this problem by saying there is no consensus on the sources of the measured efficiency and the next step is to determine these sources, which include: (1) differences in the efficiency concept used; (2) differences in measurement methods used to estimate efficiency within these concepts; and (3) explore the correlations of efficiency with respect to bank, market, and regulatory characteristics that are at least partially exogenous and may explain some of the efficiency differences that remain after controlling for efficiency concept and measurement methods. They also suggest a possible solution, by employing multiple efficiency concepts, using a number of different measurement methods and applying a comprehensive set of potential efficiency correlates to a single dataset.

Berger & Humphrey (1997) sum up the main concern regarding the best choice between the two main approaches: parametric and non-parametric. It is centred on the fact that the true level of efficiency is unknown and results in ranking of similar firms somewhat differently. They propose to add more flexibility to the parametric approaches and introducing a degree of error into the non-parametric approaches. In essence, addressing the main limitations to each approach can provide more efficient and consistent estimates. Consequently, it seems clear that the estimates of mean or median efficiency for an industry may be more consistently reliable for policy and research purposes than ranking of firms by their efficient values for both approaches.

Berger & Mester (1997) find that despite the different choices and specifications used, very little difference is observed on the average industry efficiency scores or ranking of individual firms, suggesting that efficiency estimates are fairly robust despite differences in methodology. The evidence from these two papers seems to suggest that the banking industry's efficiency is relatively easier to measure as opposed to the efficiency of individual firms. The overall summation of the lack of progress in addressing this paramount research question is a concern.

The main problems in measuring the efficiency in the banking context can be summarised from the earlier component of this section. Firstly, there is no consensus on which approach is most suitable to describe the true nature of banking. Secondly, there is no consensus about the sources of measured efficiency in the industry. The final problem is that different approaches rank similar firms differently.

The first problem seems to suggest that perhaps only one of the five approaches should be most appropriate to describe the true nature of banking efficiency. It promotes a mutually exclusive approach to the decision process, placing one approach ahead of the remaining four. Even if more than one is chosen, the problem is then shifted across to the third problem: inconsistent ranking of banking firms. However, it appears that the core of this dilemma is not so much in the choice of approaches but embedded in the issue of what is the true nature of banking? Banking business is increasingly evolving. Therefore the decision should be based on exactly where the banking operation is located on the spectrum of this evolution. More precisely, the optimal choice for measuring efficiency for banking firms in small economies could differ from that of larger economies.

The second problem is perhaps more profound and problematic to tackle than the first. The sources of measured efficiency are indeed a task worth pondering. This issue gives rise to the question: what are the determinants of banking efficiency? To put it differently, is it possible to disentangle the sources of measured efficiency to distinctly deterministic and stochastic components? While the first component clearly spells out the fundamental causes of banking efficiency, the latter accounts for the resulting variations in efficiency. In doing so, a stochastic component may become deterministic if it continues to significantly dominate the stochastic variation and vice versa. This theory could then mimic the increasing evolution in banking business and reflect the interchange of these components.

The third problem addresses the inconsistent ranking of banking firms by different approaches. This is not at all as problematic as it sounds and should not require any further effort. Resti (1997) has already correctly pointed out that this inconsistency is due to the differences in the fundamental assumptions of the efficiency approaches.

Now that the key research problems are addressed, the next question is which one of the five approaches is suitable to measure the efficiency of the commercial banks in this study.

2.4.1 Parametric Approaches

The main features of the parametric approaches have been addressed alongside SFA, DFA, and TFA. More precisely, it requires a functional form for the efficient frontier, the deviation from the efficient frontier is further divided into two separate components: inefficiency component and the error component. The literature spends a fair amount of time discussing the required efficient functional form frontier. In that, two branches of focus emerge: the economic concept of the efficient frontier, and the functional form.

The economic concept question normally deals with whether cost, revenue, or profit is the necessary concept in question. This question is far too important to be concluded here and it will be discussed in more detail in the next section.

However, the choice among these functional forms normally focuses on the traditional practice of using the translog functional form (TFF), Fourier flexible functional form (FFF), and the Cobb-Douglas functional form (CFF). The choice among these functional forms is in relation to how well the transformation parameters fit the data (Gallant, 1982). Esho (2001) argues that in a relatively small cross-section of firms, any gains from estimating the Fourier transformation parameters are likely to be outweighed by the loss of efficiency in the parameter estimates.

The required effort to assess the necessary strength of the overall parametric approaches or the nonparametric approaches is itself paramount to disentangle well justified arguments from others prior to the actual assessment.

Firstly, Bauer et al (1998) argue that parametric approaches are superior to nonparametric approaches due to the fact that the former accounts for the broader economic efficiency, while the latter only covers the technological efficiency.

Secondly, Hollo & Nagy (2006) suggest that the parametric methods are considered more sophisticated compared to non-parametric methods. This issue of sophistication may be questionable at best but it is a reminder of the most common justification for this line of econometric measurement superiority of these efficiency measurement procedures over the simple efficiency ratio.

Thirdly, Florens & Simar (2005) suggest that the parametric approaches allow for a richer economic interpretation of the production process under analysis, and are usually much easier to interpret and estimate but at a cost of a reasonable parametric specification of the models.

On the other hand, Bauer et al (1998) note that the main disadvantage of these parametric approaches is in relation to its imposing more structure on the shape of the efficient frontier, the challenge in determining how to best separate random error from inefficiency, as neither of them are observed leading to the variation in the distributional assumptions imposed to accomplish this disentanglement. This weakness is indeed potentially valid; however, its construction is merely a flipside of one of the key strengths discussed earlier.

Secondly, in relation to the pre-supposed shape of the frontier, if the functional form is mis-specified the resulting efficiency may be confounded with specification errors (Berger & Humphrey, 1997). This problem points out the flow on effect of misspecification in the efficient frontier to all other firms in the sample. In doing so, we need to develop a series of checkpoints to enhance the validity and reliability of the efficient frontier. However, this procedure is not exclusively applied to the parametric approaches, although the degree of impact is conceivably less for the non parametric approaches.

Finally, perhaps the most interesting argument against these approaches is that noted by Koetter (2006). The traditional input price proxies for SFA and possible other parametric approaches contain substantial measurement error.

2.4.2 Non-Parametric Approaches

The main features of the non-parametric approaches include the exclusion of random error and not requiring constructing an efficient frontier functional form. Since FDH is a subset of the DEA, the remaining strengths of this approach can be duplicated by the earlier discussion on the strengths of the DEA.

On the other hand, the main concern for this approach is its unaccountability for measurement error. Mester (1993) argues that data are always measured with error and it takes just one firm reportedly doing better to condemn another firm as inefficient.

Secondly, Florens & Simar (2005) suggests that the results are more difficult to interpret in terms of the sensitivity of the production of output to particular inputs (such as the shape of the production function) and inference for the measures of interest (such as confidence intervals) is not easy and the curse of dimensionality implies that large sample sizes are necessary to get sensible results.

2.4.3 Possible solution such as meeting halfway

This approach signals a sense of indecision and leads to compromise the features of the two main approaches. More precisely, Berger & Humphrey (1997) propose to add more flexibility to the parametric approaches and introduce a degree of error into the non-parametric approaches. In essence, addressing the main limitations to each approach can provide more efficient and consistent estimates. They propose to develop and implement a stochastic version of DEA, motivated by the fact that the sampling distribution of the DEA efficiency estimators remains unknown.

Bootstrapping, a re-sampling technique, is one way of obtaining an empirical approximation to the underlying sampling distribution of DEA efficient estimates. Once the underlying distribution is approximated, statistical inference can be conducted (Simar & Wilson, 2007).

Following this guidance, many researchers combine the two approaches. For instance, Florens & Simar (2005) and Margari et al (2007) integrate both parametric and nonparametric approaches in two separate phases. A parametric frontier model is estimated using a procedure: firstly, using a nonparametric method to locate the production frontier, and then adjust a parametric model to the obtained nonparametric frontier or first project all the observations on a nonparametric estimator of the frontier and then fit a parametric model to the obtained points. The method is supposedly improved by using in the first step of the procedure and a more robust order-m frontier estimator. They found evidence that their proposed method is superior by being more robust to outliers and/or extreme values than the FDH alone.

2.4.4 Possible Tie-breaker conditions

This approach was suggested by Bauer et al (1998) to assist in determining which method might be better, such as comparing efficiency results with reality, economic conditions, and other non-frontier economic performance measures to include: (1) efficiency scores should have comparable means, standard deviations, and other distributional properties; (2) different approaches should rank the institutions in approximately the same order; (3) different approaches should approximately rank the same institutions in the same category of "best" and "worst" practice; (4) different approaches should demonstrate some stability of efficiency or inefficiency over time; (5) efficiency scores should be reasonably consistent with competitive conditions in the market; (6) measured efficiencies should be reasonably consistent with standard non-frontier performance measures, such as ROA or cost to revenue ratio.

Conditions 1 – 3 are a measure of the degree of mutual consistency among the different approaches, while 4 - 6 measure the degree to which efficiency scores are consistent with reality or likely to be correct.

Examples of this procedure are abundant and growing. For instance, Berger & Mester (1997) find that the correlations between their measured efficiency results and other standard nonfrontier performance measures follow the expected pattern: efficiency is negatively and significantly correlated with the standard average cost ratios and positively and significantly correlated with the standard profitability ratios (ROA and ROE), all combined to suggest that their efficiency measures are robust and are not simply the consequences of their specifications or methods.

2.4.5 Selected Approaches for the research in the PIC

At this stage, it is obvious that TFA and FDH may not be useful. TFA needs a large number of banks or a bigger cross sectional dataset in order for it to be viable, since the dataset for this study is fairly small, TFA may not be suitable. Similarly, FDH may also be excluded based on an earlier trial run and finding FDH to be exponentially affected by the small sample size and yielding an excessive efficient number of DMUs.

Moreover, the underlying assumption for SFA, specifically the normal distribution characteristic for the random error component, statistically assumes that the sample size is large enough. In this case, it is not. Furthermore, DFA only provides a single efficiency or core efficiency over time and it is inconsistent with the research objectives in this study, as we are ideally interested in the level of individual banks' efficiency over time.

The remaining choice is DEA. In addition to the earlier discussion leading into to this decision, DEA has an additional practical justification that is not statistically based. The recent, 2008 global meltdown was largely blamed on weaknesses in the US banking system. The implication of this event is that there is a practical need for efforts to measure the efficiency of the financial institution and since DEA does not allow for random error, the overall deviation from the frontier provides plenty of opportunities to explore the possible sources and determinants of inefficiency.

The next step involves two more key decisions to be addressed: which economic concept should be used to determine the frontier and how the identifications of inputs and outputs are to be determined?

2.5 Deciding the Economic Concept

The decision regarding the preferred economic concept is perhaps more significant in the parametric approaches compared to the non parametric approaches. This emerges in relation to the construction of the efficient frontier and the two main options are the cost efficiency function (CEF) or the profit efficiency function (PEF). In some cases, revenue function and an off shoot of the PEF, known as the alternative profit functions are included. Since DEA is the chosen approach, this discussion briefly outlines the key choices. In this context, the main emphasis is on the first two.

The implication of this decision is whether the cost minimisation or profit maximisation is the fundamental objective. From the outset, the two concepts are fairly similar: how could we minimise cost and not simultaneously maximise profit or vice versa? Bos & Kool (2006) suggest that when minimising a cost function: cost-inefficiency measures the sub-optimal use of input quantities given input prices, output quantities and solvability, profit maximisation results in profit-inefficiency measures due to a sub-optimal choice of output quantities given output prices (or sub-optimal output prices given quantities). In a competitive market the two approaches should yield identical results, if the market is imperfect, and profit efficient banks may be inefficient in terms of cost and vice versa.

2.5.1 Cost Efficiency Function (CEF)

Berger & Mester (1997) note that cost efficiency gives a measure of how close a bank's cost is to the best-practice-bank (BPB) cost for producing the same output bundle under the same conditions. It is derived from the price of variable inputs, quantities of variable outputs and any fixed inputs or outputs, environmental factors, random error, and efficiency. In addition, English et al (1993) suggest that this approach assumes that outputs are determined exogenously. Both references are consistent with Farrell's (1957) suggestion that comparisons of costs must clearly be limited to situations where all the firms in the dataset to be compared should face the same factor prices.

2.5.2 Profit Efficiency Function (PEF)

Berger & Mester (1997) note that PEF measures how close a bank is to producing the standard maximum possible profit given a particular level of input prices and output prices (and other variables). In contrast to the cost function, PEF specifies variable profits rather than variable costs and take variable output prices as given, rather than holding all output quantities statistically fixed at their observed levels, thus, the profit dependent variable allows for considerations of revenues that can be earned by varying outputs as well as inputs. They argue that the profit efficiency concept is superior to the cost efficiency concept, as profit efficiency accounts for errors on both the output and input sides, and that profit efficiency is based on a more economic goal of profit maximisation. PEF may take better account of cost inefficiency since it embodies the cost inefficiency deviations from the optimal point. Vivas (1997) states that the cost frontier determines cost or input efficiency while a revenue frontier determines revenue or output efficiency and a profit frontier determines both.

The first application of profit function in banking efficiency is by Berger et al (1993b). They suggest that most inefficiency comes from deficient output revenues rather than excessive input costs and about half of all potential variable profits are estimated to be lost to inefficiency. It also reduces problems associated with misspecification mismeasurement, and pinpointing better sources of inefficiency.

2.5.3 Chosen Economic Concept for the research in the PIC

To adopt a profit based concept or frontier in this research may be problematic. In addition to the lack of explained variation in the data, a profit function is more likely to be significantly distorted by the differences in accounting practices used by different banks, and much more so, in terms of international comparisons. On the other hand, a cost based function may not suffer as severely since profit accounts for both costs and revenues variations. For this reason, cost frontier is most likely to be the leading contender.

The next step is to consider which inputs or outputs mix that are most relevant for this study. As in the last two sections, the series of options should be explored and the final decision should be justified accordingly.

2.6 Identifications of inputs and outputs

The identification of inputs and outputs for banking efficiency measurement is also well documented. However, the justification for the inclusion of inputs and outputs is not well justified and perhaps dictated by the availability, accessibility, and consistency in the presentation of financial statements. Sherman & Gold (1985) suggest that inputs should reflect the resources that are required to produce the outputs such that an increase (decrease) in output levels is expected to result in an increase (decrease) in the amount of inputs used. However, in many cases, dollar units may be the only available unit of measure.

The distinction between the main approaches is based on what aspect of the banking operation is measured. One problem associated with the difficulty in choosing banking outputs is due to banking revenues being implicit and commingled, so the flow of explicit revenues is an unreliable guide to the flow of banking services (Berger & Humphrey, 1992). They identify three approaches: the asset or intermediation approach; the user cost approach; and the value added or production approach. This summation is arguably over simplistic but the choice among these three approaches (or their detailed refinements) reflect a longstanding disagreement over what banks produce and over what resources banks consume in the process. However, the three approaches use generally different but overlapping sets of inputs and outputs, although the extent to which they generate different empirical results concerning bank performance remains an open question.

Similarly, Park & Weber (2006) note in the asset approach outputs include loans and other assets and inputs consist of deposits, other liabilities, labour, and physical capital. The value-added approach outputs include those assets and liabilities that add substantial value to the bank and inputs have labour and physical capital; and under the user-cost approach, outputs include assets or liabilities that contribute to a bank's revenues and inputs have labour and those assets or liabilities that contribute to a bank's cost of production.

Das & Ghosh (2006) incorporate another recent approach as the modern approach, citing Freixas and Rochet (1997). It goes a step further to incorporate and modify banking activities into the classical theory by integrating some measures for risk, agency costs, and quality of services. One of the most innovative facets of this approach is the introduction of the quality of bank assets and the probability of bank failure into the estimation of costs and is considered to be best represented by the ratio based CAMEL approach. The individual components of CAMEL are derived from the financial tables of the banks and are used as variables in the performance analysis. In addition, it views banks as business units with the final objective of generating revenue from the total cost incurred for running the business.

2.6.1 Intermediation (or Asset) approach (IAA)

IAA was first proposed by Sealey & Lindley (1977). Banks are considered only as financial intermediaries between liability holders and those who receive bank funds. Loans and other assets are considered to be bank outputs; deposits and other liabilities are inputs and purchased funds should be considered as bank outputs. Similarly, Gilbert & Wilson (1998) note this approach views banks as financial intermediaries, with outputs measured in monetary units and labour, capital, and various funding sources treated as inputs. Intermediation is more appropriate when banks in the sample operate as independent entities, whereas bank branch efficiency studies typically use the production approach (Bos & Kool 2006).

Siems & Barr (1998) use this approach and consider the required inputs as those resources necessary to operate a bank, outputs are those representing desired outcomes and that a best-practised bank allocates resources and controls internal processes by effectively managing their employees, facilities, expenses, and sources, and uses of funds while working to maximise earning assets and income.

2.6.2 User Cost Approach (UCA)

Berger & Humphrey (1992) argue that this approach determines whether a financial product is an input or an output on the basis of its net contribution to bank revenue. If the financial returns on an asset exceed the opportunity cost of funds or if the financial costs of a liability are less than the opportunity cost, the instrument is considered to be an output, otherwise it is an input. Park & Weber (2006) note that the typical outputs include assets or liabilities that contribute to a bank's revenues and inputs consist of labour and those assets or liabilities that contribute to a bank's cost of production

2.6.3 Production (Value Added) approach (PVA)

This approach was developed by Benston (1965) and Bell & Murphy (1968) according to Brown (2006). It considers all liability and asset categories to have some output characteristics rather than distinguishing inputs from outputs in a mutually exclusive way. Categories to have significant value added are considered as important outputs, the rest are treated either as unimportant outputs, intermediate products, or inputs. Banks are regarded as using labour and capital to produce deposits and loans, and both inputs and outputs typically measured as physical magnitudes rather than in dollars mainly used in studies of bank branches (Berger et al, 1997).

Carvallo & Kasman (2005) use the value-added approach, taking the view that banks provide two main categories of financial services: (1) intermediation and loan services, and (2) payment, liquidity and safekeeping services, consequently, deposits are considered as both inputs and outputs.

2.6.4 Other issues to consider such as the treatment of capital

Mester (1996) includes capital as an input. Berger & Mester (1997) suggest that financial capital should be incorporated into banking efficiency studies and failure to control for equity could yield a scale bias or the efficiency would be mismeasured and consequently making large banks appear to be more profit efficient than small banks by virtue of the equity they have built up over time. Similarly, McAllister &

McManus (1993) suggest that financial capital is an essential input for the intermediation process and the amount needed depends on asset risk and diversification. Capital will also impact on funding costs.

This consideration has practical merit but it falls short on justifying the primary role of financial capital or equity in banking operation. This primary role is directly related to the capital adequacy requirement and the level of equity needed by banking firms to hold as a buffer for potential loan losses. This prudential requirement also impacts upon how much profit a bank can pay out in dividends to the shareholders and how much capital is needed for future lending opportunities. Any remaining portion may well be used for lending or other purposes. In this argument, only the third component qualifies for the inclusion of financial capital as a potential input for the production purposes.

2.6.5 Chosen input/output orientation for the research in the PIC

The production approach is generally used in efficiency studies of bank branches coupled with the potential problem of accessing actual number of deposits or loans as necessary inputs conclusively exclude the PVA. Similarly, the modern approach is justified in the same manner as the PVA. The CAMEL ratings of banking firms or similar assessments by the local supervisors are often considered to be confidential and not accessible. So, the remaining two approaches: intermediation and user cost are the most likely candidates for this project.

2.7 Cross-country comparison (CCC)

The increasing level of competition across countries gives rise to a clear need for measuring and comparing x-efficiencies across borders (Berger et al, 1993a; Berger, 2007) and it may shed some light on the efficiency effects of various regulatory policies. Berg et al (1993) study of banking efficiency in the Nordic countries was the first study of banking efficiency across countries (Finland, Norway and Sweden).

One possible explanation for such effort is based on the notion that significant dispersion of efficiency within individual countries may be exploited by efficient foreign banks (Weill, 2004) and the most efficient banks will have a competitive advantage (Dietsch & Lozano-Vivas, 2000). They suggest that a clear distinction to be addressed is the underlying objective of the comparisons: a macro level or micro level study, where the former aims to determine the national average efficiency levels and vice versa.

Several factors can generate efficiency differences across banking sectors such as discrepancies in operational environment and different managerial abilities. Operational environment or country specific-elements can derive from macroeconomic differences or dissimilar characteristics of financial infrastructure and institutional system, as well as from other country specific factors. The study by Hollo & Nagy (2006) underpins the importance of accounting for heterogeneity in operational environment.

International comparisons of banking efficiency either consider comparisons based on national frontiers or adopting a common frontier by pooling all cross-country banks into one dataset (Chaffai et al, 2001). Separate frontiers cannot be used to compare differences in efficiency between countries because they do not allow a comparison to be made of the banks of each country with respect to the same standard. Common frontiers should allow a controlling measure for differences in technology. Pastor et al (1997) suggest a consideration for the assessment of comparable technologies used among all countries to be established before the common frontier should be used.

2.7.1 The homogeneity assumptions across dataset

The main concern regard the feasibility of the cross country comparisons is in relation to the homogeneity assumptions from the economic environment, prudential requirements, technological and managerial levels. This phenomenon is echoed by Berger & Humphrey (1997). They suggest that cross-country comparisons can be difficult to interpret as the regulatory and economic environments faced by financial institutions are likely to differ across nations and consequently the level and quality of service associated with banking activities may differ in ways that are difficult to measure. To put it slightly differently, systematic differences between banks can be wrongly dubbed as inefficiency if compared against a uniform frontier that is not adjusted for heterogeneity (Koetter, 2006).

Another potential consideration to address in these cross country comparisons is the measurement basis for inputs and outputs, more precisely: do we need to transform both inputs and outputs values and prices into a common currency or by some other means. Allen et al (2006) suggest that all variables should be deflated by the consumer price index. This type of considerations gives rise to the next issue of addressing country specific conditions and environmental effects.

2.7.2 Country specific conditions and environmental effects

Cross-country comparisons have to account for potential differences arising from certain country-specific aspects of the banking technology on one hand and from the environmental and regulatory conditions on the other. Dietsch & Lozano-Vivas (2000) note that this is the first systematic comparison of efficiency measures across countries using DFA and the inclusion of environmental variables into the definition of the common frontier. The three economic variables include: macroeconomic conditions, structure and regulation, and accessibility of banking services. This is justified when the environmental variables are included in their analysis of the French and Spanish banking industries, the differences in the two countries are reduced substantially.

Chaffai et al (2001) show that efficiency variation is due mainly to the consequences of environment differences and their breakdown of productivity index confirms this assessment. Specifically, the inclusion of environmental conditions diminishes differences in banking technology; and the differences due to environmental conditions are always larger than the differences due to banking technology.

Carvallo & Kasman (2005) look at the cost efficiency of 16 countries in the Latin American and Caribbean regions and three environmental variables were identified to include geographic, market structure, and financial depth. The geographic variable includes measures of population density, income per capita, and density of demand. The concentration variable includes concentration ratio, average capital ratio, and intermediation ratio. The financial depth variable includes a proxy for accessibility of banking services, money growth, and GDP growth. Consequently, high efficiency banks are located in high population densities while low efficiency banks are associated with low population densities (Kaparakis et al (1994)).

Allen & Rai (1996) further standardised input prices from different countries into a comparable unit, using the US currency and the end of year exchange rates as the basis for conversion. Converting currencies into a common currency can use either the official exchange rate or the purchasing power parity (PPP), though the two approaches should yield similar results (Casu & Molyneux, 2003). This is also similar to Berg et al (1993) where both PPP and exchange rates yield similar results.

Carvallo & Kasman (2005) estimated the average inefficiency scores for each country both based on their national frontiers and common frontier without country-specific environmental variables. Their findings indicate that the average inefficiency scores based on national frontier fluctuate greatly across countries, thus justifying the employment of a common frontier for all countries. Without taking country-specific environmental variables into account, the average inefficiency score is 0.178 and when environmental factors are incorporated, inefficiency levels increase remarkably in most countries, thus, justifying the application of the country-specific variables.

Greater competition and the dominant degree of foreign ownership encouraged the implementation of best practices (advance risk management, corporate governance techniques and accounting methods) and the transfer of know-how and well educated labour forces enhanced productivity gains and integration. Thus the effect of the connection between parent banks and subsidiaries is now regarded as a very important feature, a theme for future research. However, the increasing number of mergers and acquisitions are aimed at either boosting market power or improving efficiency (Hollo & Nagy, 2006).

In comparing bank performance in different countries, two main issues had to be considered: how different are the underlying domestic banking technologies and which particular environmental and regulatory conditions characterise the banking markets? Thus, it is necessary to break down the intercountry performance differences into pure technological differences and differences due to environmental effects (Chaffai et al, 2001). Chaffai et al find that productivity gaps between countries are very sensitive to environmental conditions and even if a country uses better technology, it can be less productive due to hostile environment.

2.8 Chapter Summary

This chapter has discussed the key components of the literature subject only to the practical need of measuring the efficiency of the commercial banks in the Pacific countries. The scope of the discussion is fairly expansive and perhaps excessive. This is justified based on the notion that a researcher has an obligation to scope the horizon and carefully select what is most suitable, relevant, and potentially useful for the development and construction of the methodology.

Finally, DEA is the most relevant approach, cost provides the basis for the economic concept, and intermediation is justified as the model orientation for the selection of inputs and outputs.

Chapter 3: The Six Banking Frameworks

3.1 Introduction

This chapter discusses the prudential framework the commercial banks are subjected to under each of the six banking systems. Other financial institutions such as development banks, credit unions and other non bank institutions are not included. Although they play a significant role in the banking system and the economy, they are subjected to a less stringent set of guidelines compared to the commercial banks. Similarly, offshore banking facilities are not included, since they are mostly excluded from receiving deposits and issuing loans locally and their operation is more of a fee income source for the local government (Tschoegl, 2005) although they provide local employment opportunities.

The scope of the discussion is primarily focussing only on some of the key prudential requirements that are most likely to significantly mould the productivity and the measured efficiency of the commercial banks. This limitation is essential for a number of reasons: banking systems are considered as the most regulated industry in the financial system (Sinkey, 2002); the basis for prudential requirements is to promote economic growth in a sustainable manner while maintaining safety and soundness of the banking industry; it is not comprehensible that every prudential requirement equally promotes this purpose proportionately; and given the long list of prudential requirements, it is impossible to include all requirements. This approach follows the discussion of the micro oriented approach (discussed in section 1.6.1).

An obvious drawback of this limited scope is the exclusion of the local monetary policy, interbank markets, exchange rate volatilities, and the fiscal foreign reserves. It is inevitable that bank efficiency can be impacted by challenges from one or all of these variables at any given time. For instance, monetary policy does influence commercial banks' interest rates, the local interbank market plays a significant role in facilitating commercial banks' short term liquidity needs, exchange rate movements can affect the commercial banks' forex operation, and a shortage of fiscal foreign reserves could put pressure on the local central bank and commercial banks in several ways[5].

On the other hand, pursuing the impact of each of these variables is enormously challenging in its own right, hence, the impact of prudential requirements on bank efficiency is more meaningful to pursue. Furthermore, the interactions between these variables and bank efficiency are inevitable.

However, the main challenge in this approach is that this perceived scope has not been adequately or formally discussed in the banking efficiency literature. Hence, the most immediate issue is to establish which prudential requirement(s) is most relevant to this scope of discussion.

This underlying question dominates the structure of this chapter. The next section explains the core principles for effective banking supervision. This is followed by a theoretical discussion on the likely impact of prudential requirements on bank efficiency. Thus provides the basis for the discussion of the six prudential frameworks. The final section, 3.11, contains a brief chapter summary.

3.2 Core Principles for Effective Banking Supervision

The discussion of the prudential requirements for any jurisdiction in the banking industry should incorporate the Core Principles for Effective Banking Supervision by the Basel Committee (1997), also known as the Basel Core Principles (BCP). The BCP first published in 1997 and later amended in 2006. These principles were established to provide a basic reference for effective banking supervision and promote a more conforming approach among countries.

Both versions of the BCP have 25 fundamental principles and the latest is considered to strengthen the former guidelines. This discussion focuses more on the original

[5] More precisely, the last three variables all have some direct impact on the challenges for monetary policy for these small economies. For instance, lack of a secondary market for local government debt instruments poses challenges for commercial banks' liquidity management, exchange rate volatilities puts more pressure on the fiscal foreign reserve, which is generally a focus of monetary policy alongside inflation across the region.

version, since the later version emerged at the end of the period (2000 to 2006) under this study. The principles are divided into seven key categories: preconditions for effective banking supervision; licensing and structure; prudential regulations and requirements; methods for ongoing banking supervision; information requirements; formal powers of supervisors; and cross-border banking.

While all seven categories are essentials for effective supervision, the focus here is on the third category: prudential regulations and requirements. This category carries the most principles, ten altogether: principle 6 to principle 15. The coverage within these 10 principles is also extensive and consequently, the focus is revised to include only five: principles 6, 8, 9, 10, and 13. The rationale for this realignment is based on the relative application of these principles to the six banking systems, and the availability of quantitative data for the sake of assessing the variation in these prudential requirements. Principle 7 concerns credit risk management, principle 11 addresses country and transfer risk, principle 12 is market risk management, principle 14 considers internal controls, and principle 15 promotes the strict "know-your – customer" rules and the prevention of banks being used for criminal activities. The most obvious feature of these five principles is that they are predominantly qualitatively based.

The exclusion of principle 7: credit risk management is debatable. It focuses on the policies and procedures related to granting loans and the management of the loan portfolio. The importance of this principle is not overlooked as principles 8, 9, and 10 quantify this qualitative procedure to some extent.

Principle 6 quantifies the appropriate minimum capital adequacy requirements (CAR). More precisely, banks should hold 4% tier one capital and a total of 8% in relation to risk weighted assets. These ratios are the minimum standard and supervisors should consider requiring higher ratios when the risk profile of a bank is doubtful regarding the asset quality or other adverse characteristics of a bank's financial conditions.

Principle 8 promotes the assessment of asset quality and the adequacy of loan provisions. While this principle falls short on prescribing how asset quality and loan provisions ought to be quantified, local supervisors and accounting reporting standards account for this based on local conditions and past experiences. This principle is not addressing the creditworthiness of the borrower, as it is a likely component of principle 7. Rather, it is emphasising the ongoing need to monitor the borrower's likelihood or ability to repay loan obligations, especially if repayment is doubtful, late, or likely to default. Therefore, this principle quantifies principle 7.

Principle 9 addresses the concentration of risk and large exposures and principle 10 raises the alarm in preventing potential abuses arising from connected lending. Both principles indicate the risk associated with the composition of the loan portfolio and limiting excessive exposures to a single counterparty. These two principles are most likely to be most relevant and challenging for the region, especially in a small economy where the availability of credit is most likely to be affordable only to a small concentration of individuals, businesses, and government agencies. Again, these two principles quantify principle 7: credit risk management.

Principle 13 picks up on the remaining components of risk management that have not been previously addressed to include interest rate risk, liquidity management, and operational risk. The second component is considered most relevant in terms of its current application within the context of these six banking systems. In the absence of deposit insurance, a requirement to hold statutory deposits at the central bank is common and lack of compensation in interest for such holding is a cost for the commercial banks considering they still pay interest to their customers. Similarly, liquidity requirements normally force commercial banks to hold a certain level of liquid assets at all times at the cost of forgoing lending opportunities. Both requirements are obviously significant in determining the remaining deposits available for funding banking activities.

The incremental contribution of the BCP in measuring banking efficiency between countries is that prudential requirements can be compared against each other, it is used as a reference point and potential causes for the variations in bank efficiency between countries. On the other hand, comparing bank efficiency within a country under the same prudential requirements and economic conditions, the BCP may be less dominant.

3.3 Bank Efficiency and Prudential Requirements

The main issue here is what happens when prudential requirements are incorporated into bank efficiency measurement? Specifically, do prudential requirements promote or discourage bank efficiency? As we have noted earlier, the predominant emphasis of the prudential requirements is bank safety and soundness while promoting sustainable growth. This dual role ought to portray the notion that prudential requirements are not in place to serve a mutually exclusive objective: neither bank safety nor banking growth in isolation. In that context, prudential requirements should be considered as a compromising and balancing tool in achieving both objectives simultaneously.

This consideration gives rise to the distinction of banking systems as universal and separated banking systems. Before we discuss the distinction between these two banking systems, the potential impact of the prudential requirements on bank efficiency is presented.

CAR is renowned for its defensive potential against banking risk and promoting stability. However, in the context of bank efficiency it should play a significant role. For example, if the CAR is set much higher compared to the BCP standard, then a bank's ability to issue loans or produce banking output is compromised, productivity is reduced and consequently resulting efficiency is likely to be reduced. Despite the reduction to both productivity and efficiency, bank stability is most likely to be strengthened mainly due to the marginal reduction in issuing loans. On the other hand, if CAR is set below the BCP standard, productivity is likely to increase due to the increasing level of output but at the expense of increasing credit risk, and capital resources is by comparison, proportionately reduced.

In contrast to the CAR, liquidity requirements could potentially impact productivity and efficiency differently and through banking input, while the impact on stability remains similar to the CAR. If both liquidity requirements and statutory deposit requirements are relatively high then two scenarios emerge: if both requirements are deducted from the deposits available for banking activities then input is reduced leading to a higher productivity and efficiency; otherwise, productivity and efficiency are expected to decline since the volume of the input increases (as it is not deducted).

The potential impact of credit exposure on efficiency and productivity is similar to the reversal impact of the CAR. If the restriction on credit exposure is too low then the productivity and efficiency is most likely to increase since output from a single counterparty increases but at the expense of increasing risk and consequently, stability is severely compromised. On the other hand, if credit exposure is set relatively high then productivity and efficiency are reduced but stability is strengthened.

In accounting for asset quality, adequate loan provisions are considered to provide and account for the variation in asset quality; however, it is not as straightforward as the other requirements. Output is affected through the resulting net loan portfolio, as provisions are deducted from the gross loan while input is affected by the annual expense component of loan provisions. Even this expense item is subjected to the collectivity of loan losses resulting in further uncertainty in relation to the resulting impact on efficiency and productivity. Assuming that the collectability of loan losses is not adjusted (purely for simplicity), high provisions result in low productivity and efficiency but promoting stability on the output front and on the input front: provision expenses is expected to increase resulting in declining productivity and efficiency but stability is strengthened. On the other hand, low provisions lead to increasing output and decreasing input, resulting in increasing productivity and efficiency and the expense of compromising bank stability.

3.3.1 Universal and Separated Banking Systems

The inclusion of this section is based on the notion that commercial banks cannot expand the scope of their operation outside the non traditional banking activities of collecting deposits and issuing loans without formal consent from the banking supervisor. This aspect is also relevant to the measured efficiency of banking firms in terms of the economies of scale and scope efficiencies earlier explained in the literature chapter.

Universal banking systems commonly refer to prudential frameworks that lean more towards encouraging banking growth and placing little restrictions in banking firms operations in non-traditional banking activities. On the other hand, separated banking systems place more emphasis on bank stability by strongly restricting engagement in such activities.

In a study of the efficiency and performance of universal banking activities in Switzerland, some evidence of large inefficiencies in both cost and profit and lower efficiency estimates are identified when focussing on traditional banking activities alone, although a lower degree of profitability is observed in banks solely engaging in traditional activities compared to those engaging in universal banking activities (Rime & Stiroh, 2003).

The data for this section is based on a survey conducted by Barth, Caprio, and Levine (2001). There are four activities included: trading securities, underwriting and selling insurance, lending and underwriting, development and management of real estate (more of commercial developments as opposed to housing) and bank's ownership of non-financial firms. Under each activity, there are four sections including: unrestricted, permitted, restricted, and prohibited. Unrestricted means a total or full range can be conducted by banks, permitted assumes that a full range can be conducted but engagement is through subsidiaries, restricted reflects some form of constraints in engagement but generally allowed through either bank or subsidiary, and prohibited implies that banks and subsidiaries are forbidden to engage in such activity.

This cross sectional variation can be used to quantify the regulatory stance in relation to each of these activities. Unrestricted receives 3 points, permitted has 2 points, restricted has 1, and zero if the activity is forbidden. Therefore the maximum score is 12 reflecting all activities are unrestricted and banks are totally free to engage while the minimum of a zero score is the opposite. Countries on the high end reflect the universal banking systems category and the low end are separated banking. The assessment for each PIC is included in the following sections.

On the other hand, despite the expected variation across the PICs, it is likely that non-traditional banking activities may not have any significant impact on bank efficiency and productivity; as such activities may be shallow or not even exist in the first place.

The resulting summation of this discussion presents the opportunity cost associated with prudential requirements (Mayes et al, 2001); prudential requirements balancing role could result in favouring one role (growth) over the other (stability); and finally, could it be possible to distinguish which component of bank efficiency is due to managerial performance and local prudential requirements in a cross country comparison context.

3.4 Overview of the Six Banking Frameworks

The following table presents the comparable size of the six banking systems. The data is presented for 2005 since the local structure for each banking system is least affected by any significant change or restructuring. This sum of all commercial banks' assets is converted into USD using the average exchange rate for 2005, noting the variation in the balance date among the commercial banks.

Table 3.4A: Commercial Banks' Assets in USD m for 2005

Country	Total Assets	Regional Share
PNG	1,724.85	40.06%
Fiji	1,599.72	37.15%
Vanuatu	494.99	11.50%
Samoa	215.29	5.00%
Tonga	145.15	3.37%
Solomons	125.85	2.92%
TOTAL	4,305.85	100%

This table reflects the sheer dominance of the two largest banking systems: PNG and Fiji and the last three countries (Samoa, Tonga and Solomon) overall asset share account for just about the same share of Vanuatu, the third largest of the six PICs.

The structure of the banking systems in the region is more or less reflected by the political and economic foreign influence in that particular part of the region. For instance, where Australia is most influential, the Australian based banks seem to dominate the banking market (except in PNG), a similar observation can be extended to the parts of the region dominated by the French but this scenario is less obvious where the US dominance influence is observed (Tschoegl, 2005). The Australian sphere of influence also comprises of former spheres where the British and New

Zealand were dominant, though banks from both countries have either left or sold to the Australian based banks. Not surprisingly, the chosen six countries for this research are all part of the regions where Australian influence is dominant.

Another feature of the commercial banks in the Pacific region is the dominance of foreign banks, particularly the two Australian banks: ANZ and Westpac. ANZ accounts for about 40% of the overall commercial banking assets in all six PIC in 2005 and Westpac's share is about 24%. Thus both banks' asset share amount to over 60% throughout the six countries.

Table 3.4B: Three largest commercial banks in 2005 across the six PICs

		Asset in USD m	Total	% Share
ANZ	Tonga	58.30		
	Fiji	677.24		
	Samoa	119.28		
	PNG	481.50		
	Solomon	38.83		
	Vanuatu	297.75	1,672.91	38.85%
WPC	Tonga	77.94		
	Fiji	457.13		
	Samoa	50.85		
	PNG	263.47		
	Solomon	32.59		
	Vanuatu	150.26	1,032.25	23.97%
BSP	PNG	941.87	941.87	21.87%

A notable exception is the PNG based Bank of South Pacific (BSP) with an asset share of slightly over 20% from its PNG operation alone. It has recently acquired the National Bank of Solomon Islands (April 2007), Habib Bank (December 2006) and Colonial National Bank (December 2009) in Fiji. While BSP's share of the commercial banks' assets is slightly below WPC, it is likely to grow even further when its operation in Fiji and Solomon are taken into consideration.

3.4.1 The Association of Financial Supervisors of Pacific Countries (AFSPC)

The AFSPC was created in 2002 by eight Heads of Banking Supervision in the Pacific region, endorsed by the governors of central banks and ministers of finance. Inaugural members include the Federated States of Micronesia, Fiji, Papua New Guinea, Republic of Marshall Islands, Samoa, Solomon, Tonga, and Vanuatu. The Cook Islands and Palau joined in 2003. Australia, New Zealand and Hawaii are observers. The Pacific Financial Technical Assistance Centre acts as secretariat, with administrative backing from the Reserve Bank of Fiji.

In endorsing the formation of the AFSPC, the participants sought an alliance to represent the voice of the Pacific in international forums where financial supervision issues are discussed. The main operational objectives include: promoting closer co-operation, co-ordinates information sharing in financial regulation and supervision in Pacific countries; strengthening the financial sectors of Pacific countries by promoting international standards, best supervisory practices, and encouraging financial institutions to adopt sound risk management processes; enhancing supervisory skills, encourage the development of high professional standards by facilitating training, and the dissemination of resource materials; acts as the representative of its members on financial supervision with international and regional organizations, actively pursue dialogues with these organizations; and supporting anti-money laundering and other initiatives related to financial supervision.

Perhaps the most obvious significant contribution of the AFSPC is to channel international best practices in banking supervisions to the region. Hence, recent developments in the regions banking systems can be attributed to the efforts of the AFSPC. It is most evident in efforts to realign the supervisory framework in the regions with the BCP.

3.5 The Tongan Banking System

Land Area (km^2)	727
Population (2000)	100,300
Local Currency	Tongan Pa'anga (TOP)

3.5.1 Banking Structure in Tonga

The National Reserve Bank of Tonga (NRBT) was established in 1989 under the NRBT Act 1988. It is the banking supervisor, also dictated by the Financial Institution

Act 2004 (replacing the 1991 Act), effective from November 2005. The underlying motive behind this new Act is to strengthen the supervisory role of the NRBT by conforming to the internationally accepted standards, as embodied in the Basel Core Principles. The supervisory power of the NRBT is restricted to the licensed financial institutions only. There are currently four licensed financial institutions (LFI); three of them are commercial banks: Westpac Bank of Tonga (WBT), ANZ Bank, Malaysian Banking Finance (MBF) Bank Limited, and the Tonga Development Bank (TDB). WBT, MBF, and TDB are locally incorporated and ANZ operates as a branch.

Table 3.5: Tongan Commercial Banks' asset share in 2005

Commercial Banks	Total Assets 2005 (TOP m)	Total Asset 2005 (USD m)	Asset Share (%)
Westpac	141.5	72.6	53.7
ANZ	104.9	53.8	39.8
MBF	17.2	8.8	6.5
TOTAL	$263.6	$135.2	100%

2005 Average Exchange Rate: USD=TOP 1.9491

WBT was the first trading bank in Tonga, started in 1974 as the Bank of Tonga under the Bank of Tonga Act 1972.There were four shareholders: 40% owned by the government, 20% owned by the Bank of New South Wales (now Westpac Banking Corporation (WPC), 20% owned by the Bank of Hawaii (BOH) and the remaining 20% owned by the Bank of New Zealand (BNZ). In 2000, both BOH and BNZ sold their shares to WPC and the name of the bank changed to Westpac Bank of Tonga (WBT) in 2001. WBT became a joint venture between the government holding 40% and WPC has the remaining 60%. However, in July 2008, the government sold its 40% shareholding to WPC, taking full ownership. This transition is the most notable effect of the 2008 global crisis in the region, however, it was driven more by the bank's obligation to finance the government's fuel imports during a period of high oil prices.

WBT is the largest of the three commercial banks, accounting for about 54% of all commercial banks assets in 2005. In 2006, it had six branches and six ATM machines in Tonga: three branches and three ATM in Tongatapu, one branch and an ATM in Vava'u, one branch and ATM in Ha'apai, and one branch and ATM in 'Eua.

ANZ started operating in Tonga in 1993 and by 2006 it had a branch in Tongatapu and a sub-branch in Vava'u and three ATM machines in Tongatapu and one in Vava'u. It is the second largest commercial bank in terms of total assets, amounting to about 40%.

MBF started operating in 1993, a subsidiary of the MBF Asia Capital Corporation Holdings Ltd owning 93% of shares, and the remaining minor shareholders are: H.M. King George Tupou V (3%); Tonga Co-operative Federation Ltd and Tonga Investment Ltd. It has a branch in Tongatapu and Vava'u. As the smallest of the three commercial banks, total assets amount to the remaining 6%.

3.5.2 Banking Regulatory Framework in Tonga

The capital adequacy requirement (CAR) was set at 15% of risk weighted assets, higher than the traditional 8% level currently practiced in other jurisdictions. It was later reduced to 8% in 2004 under the Financial Institution Act (FIA) 2004 and consistent with the BCP. However, the commercial banks have been adequately capitalised throughout 2000 to 2006, reaching around 28% in 2004 before sliding off to just over 21% in 2006.

The liquidity requirements for the commercial banks are dictated by the Liquid Asset Ratio (LAR) and the Required Reserve Ratio (RRR) or also known as the statutory reserve deposits (SRD). In relation to the LAR, all licensed financial institutions are required to maintain a minimum holding of 5% of liabilities in specified eligible liquid assets at all times. In 2006, the NRBT board approved that the SRD can be used as eligible security for borrowing from the central bank, thus providing temporary liquidity support. RRR was introduced in March 1993 at 5%, raised to 10% in December 1995, 12% in September 1998 and 15% in September 2000, and later reduced to 12.5% in March 2006 and 10% in April 2007. This requirement includes both domestic liability and net foreign liability. There is no interest payable on these deposits; however 1.5% interest per annum is paid if the balance held with the NRBT exceeds $1 million of the RRR.

In November 2002, credit risk classification was amended from three categories of substandard, doubtful and loss to five categories. Those five categories include the previous three categories and the two additional consideration of standard and special mention. The first reflects no element of doubt regarding a borrower's ability to fulfil repayment obligations on both interest and principal, where the latter does reflect a relative higher degree of risk but a loss is not expected at this stage and likely to occur if adverse conditions persist, however no provisional requirements required for both. Provisional requirements for the remaining categories stay at 20% for substandard, 50% for doubtful and 100% for the loss category.

Connected lending and large exposures are restricted under the Financial Institution Act 1991. Section 14 (1) (A) notes that a licensed financial institution shall not grant to any persons or group of persons any advance, credit facility or guarantee in total at any time more than 30% of the issued capital. A unique feature of this Act is that government agencies can borrow beyond this 30% threshold, in such a case it could compromise bank stability.

In addition to the previous requirements, temporary requirements can be used to counter supervisory concern regarding unsustainable lending activities. For instance, a statutory credit ceiling was imposed on the commercial banks in June 2006 mainly on individual banks lending to the non-financial private sector. The imposition of the credit ceiling was focussed to counter the unsustainable growth in credit and protecting the level of foreign reserves (Mafi, 2006). The credit ceiling has now been abolished since January 2007.

The disclosure requirements for all commercial banks are applied to the TDB, as it is a licensed financial institution (LFI). This measure was further strengthened under the FIA 2004, and became effective by August 2007. The impact of this prudential requirement is the inclusion of the ANZ operation in the disclosure framework. Prior to 2004, ANZ was not required to disclose its financial statements to the public.

3.5.3 Non-Traditional Banking Activities in Tonga

Commercial banks are unrestricted and able to engage in all securities activities such as securities underwriting, brokering, and dealing in aspects of the mutual fund industry (3 points). Participation in the insurance industry, such as engaging in underwriting and selling insurance is permitted (2 points). Banks are prohibited to engage in real estate development and management (0 point). Banks' ownership of non-financial firms is permitted (2 points). Thus the overall degree of allowance to engage in non-traditional banking activities is **7** out of a possible 12. Overall, the supervisory framework is fairly flexible in terms of allowing commercial banks to engage in non-traditional banking activities and the Tongan banking system can be considered to belong to the Universal banking framework.

3.6 The Fijian Banking System

Land Area (km^2)	18,272
Population (2000)	811,000
Local Currency	Fijian Dollar (FJD)

Fiji is the largest and most developed economy in the South Pacific region (excluding Papua New Guinea which is larger but less developed) and is the least aid-dependent Pacific nation.

3.6.1 Banking Structure in Fiji

The Reserve Bank of Fiji (RBF) is the banking supervisor. The scope of supervision focuses on institutions that accept deposits from the public and invests these funds either in loans or investments, currently including banks and credit unions (dictated by the Banking Act 1995) and the insurance companies, brokers, and agents (dictated by the Insurance Act 1998) and pension funds. There are currently six commercial banks and three credit unions, seven general insurers, two life insurance companies. In August 2003, the RBF's supervisory net was further expanded to include the Fiji National Provident Fund as its total assets exceed the sum for all six commercial banks. Fiji Development Bank is not licensed by the RBF however; off-site (on-site was conducted in November 2004) monitoring is conducted by the RBF as directed by the Minister of Finance and National Planning.

The commercial banks are: ANZ Banking Group Ltd (Australia), Westpac Banking Corporation (Australia), Colonial National Bank (Fiji & Australia, former National Bank of Fiji), Bank of Baroda (India), Habib Bank Ltd (Pakistan), and Asset Management Bank Fiji Ltd (Fiji). AMB is winding down its operation and does not provide commercial banking services, nor was it required to prepare or publish disclosure statements under section 28 of the Banking Act 1995. AMB is the former operation of the failed government owned National Bank of Fiji during the late 1990s.

The six commercial banks in Fiji account for $3.043b (39%) of the overall assets in the financial system $7.837b in 2005 (excluding the Reserve Bank of Fiji). This ratio is interesting as it reflects the financial depth in Fiji beyond the commercial banks and the estimation of its asset share is also strengthened by the RBF's wider scope of supervision. Since AMB is winding down and has not provided commercial banking services, the remaining five commercial banks will be included in the study.

Table 3.6: Fijian Commercial Banks' asset share in 2005

Commercial Banks	Total Assets 2005 (FJD m)	Total Asset 2005 (USD m)	Asset Share (%)
ANZ	1,142.2	675.4	42.2
Westpac	779.4	460.9	28.8
Colonial National Bank	490.5	290.0	18.1
Bank of Baroda	267.3	158.1	9.9
Habib Bank	29.0	17.1	1.1
TOTAL	$2,708.4	$2,847.3	100%

2005 Average Exchange Rate: USD=FJD 1.6911

The ANZ bank has been operating in Fiji since 1951 after absorbing the operation of the Union bank's operation. In 1985, it acquired Barclay bank operations, established in 1973. Then in 1990, Bank of New Zealand's operations were also acquired, followed by another acquisition of the Bank of Hawaii's operations, which started in 1993. It is the largest commercial bank in Fiji, accounting for over 42% (in 2005) of the overall commercial banking assets. In 2007, ANZ had 16 branches, 58 ATMs, and an extensive EFTPOS network throughout the country.

Westpac started operating as a branch in 1951, as the Bank of New South Wales. In 1988, it acquired the operations of HSBC. HSBC exited after considering the 1987 coup environment as unpromising (Tschoegl, 2005). It is the second largest of the commercial banks, amounting to just about 29% of total assets in 2005. In 2007, there were 18 branches of Westpac and 16 ATM machines.

Colonial has been operating in Fiji as a life insurance company since 1876, owned by Colonial National Bank (CNB). In 2000, Commonwealth Bank of Australia (CBA) bought Colonial and its stakes in CNB and the National Bank of Fiji, the government established bank operation since 1974. In January 2006, CBA acquired the government of Fiji remaining 49% shareholding in CNB. Its share of commercial banking assets in 2005 was about 18%, the third largest of the commercial banks. CNB has been (December 2009) sold to the PNG based Bank of South Pacific.

BOB started operating as a branch in 1961, mainly offering banking services to the Indian community, Baroda being a city in Gujarat and its cultural capital (Tschoegl, 2005). In 2005, BOB accounted for about 10% of the overall commercial banking assets and it is the second smallest commercial bank.

Habib Bank is Pakistan based, started operating in Fiji since 1991 as a branch, and caters predominantly to trade with Southeast Asia and Muslims. Habib's share of the commercial banking assets was slightly over the 1% threshold and it has been the smallest of the commercial banks operating in Fiji. In December 2006, the operation was sold to the PNG based Bank of South Pacific.

3.6.2 Banking Regulatory Framework in Fiji

RBF started endorsing capital standards in 1992 and the current standard was established under the Banking Act 1995, effective from December 1997. CAR is in line with the BCP at 8% of capital to risk adjusted assets. However, RBF retains the right to require a financial institutions to maintain a higher ratio where special factors so require.

There is no formal minimum liquidity requirement imposed on commercial banks, compared to a 10% imposed on the credit unions. However, a prescribed Liquidity Risk Management Policy (LRMP) for banks was initiated under the Bank Act 1995 in 2005 and effective from 1 November 2005. One of the key interesting features of this policy is the requirement for each bank to establish an Asset Liability Committee (ALCO). There is a statutory reserve deposits (SRD) requirement. SRD was set at 6% of total deposits and similar liabilities, lowered to 5% (1997) and then increased to 7% in May 2006. Interest is paid on the SRD at the prevailing 91 Day RBF Note (monetary policy instrument) Rate.

Loan classification and provisions for impaired assets was endorsed in 1996, and reviewed, and effective from April 2002. The original provisioning standards classified loans into three categories: substandard, doubtful, and loss. The RBF Banking Supervision Policy Statement (BSPS) No.3, section 5.8 and 5.11 suggests that serious asset quality problems exist when the sum of Substandard, Doubtful, and Loss exceeds 10% of the total loan portfolio. The revised standard extends the requirements to both on and off-balance sheet exposures such as guarantees, acceptances and other type of advances. The loan classification is also expanded to five categories: standard, special mention, substandard, doubtful, and loss. The provisioning requirements are similar to that in Tonga with the last three accounting for 20%, 50%, and 100% respectively.

Credit exposure was regulated under the Banking Act 1995 in March 1998 and a single borrower or borrower group is limited to 25% of capital, which is in line with the recommendation of the BCP. However, an exemption can be sought via a formal application to the RBF in conjunction with an issued Ministerial Order for the Minister of Finance and Economic Development. This requirement also applies to exposures to connected parties. In supplementing this measure, the RBF requires quarterly details of borrowers or groups with borrowing over the 10% threshold of a financial institution's total capital. Alternatively, the 15 largest exposures must be reported. The exposure concentrations to certain economic sectors or industries are also noted but the onus of responsibility is on the financial institutions themselves.

All supervised institutions are required by the Banking Act 1995 to publish disclosure statements annually, effective for all financial years ending on or after 31st December 1999. The disclosure statements are in two parts: a brief key disclosure statement (KDS); and a more detailed general disclosure statement (GDS). KDS contains key audited financial information, designing to provide an overview of the institution's financial condition including: capital adequacy (both tier I & tier II), disclosing the amount and provisions for impaired assets, profitability from both local and global operations, total assets, and asset growth, and a summary of the Balance Sheet and Income Statements. GDS aims to provide more detailed information including: banking activities, comprehensive information on both balance sheet and profit and loss statements, banking risks management, unit trust or managed fund activities, banking concentration of lending to different geographical regions and industries.

3.6.3 Non-Traditional Banking Activities in Fiji

Commercial banks are permitted to engage in all securities activities such as securities underwriting, brokering, and dealing in aspects of the mutual fund industry (2 points). Banks' participation in the insurance industry is prohibited (0 points) so are engaging in real estate development and management (0 point). Banks' ownership of non-financial firms is not available (0 points). Thus the overall degree of allowance to engage in non-traditional banking activities is 2 out of a possible 12. Overall, the supervisory framework is very restrictive in terms of prohibiting commercial banks to engage in non-traditional banking activities. The Fijian banking system is a separated banking system.

3.7 The Samoan Banking System

Land Area (km^2)	2,935
Population (2000)	170,700
Local Currency	Tala (WST)

3.7.1 Banking Structure in Samoa

The Central Bank of Samoa (CBS) is the banking supervisor, established in May 1984 and dictated by the Central Bank of Samoa Act 1984 and the Financial Institution Act

1996, amendments in 2001, taking over from the Monetary Board. Following the 2001 amendments, the scope of supervision is extended to other financial institutions such as the Samoa National Provident Fund, the Development Bank of Samoa, and recently extended to cover the insurance industry, as dictated by the Insurance Act 2007, replacing the Insurance Act 1976. This new Act effectively transfers the licensing and supervisory functions of the Insurance industry from the Ministry of Finance to the CBS and aims to achieve compliance with the Insurance Core Principles adopted by the International Association of Insurance Supervisors. There are four commercial banks: ANZ Bank (Samoa) Ltd, Westpac Bank Samoa, National Bank of Samoa (NBS), Samoa Commercial Bank (SCB).

Table 3.7: Samoan Commercial Banks' asset share in 2005

Commercial Banks	Total Assets 2005 (WST m)	Total Asset 2005 (USD m)	Asset Share (%)
ANZ	327.3	120.8	54.6
Westpac	128.7	47.5	21.5
National Bank of Samoa	63.4	23.4	14.1
Samoa Commercial Bank	58.9	21.8	9.8
TOTAL	$599.1	$213.5	100%

2005 Average Exchange Rate: USD=WST 2.7103

ANZ entered in 1991 after acquiring 50% of the Bank of Western Samoa (established in 1959) from BNZ and 25% from the government, and later acquired the remaining 25% in 1995. In 2007, it had six branches and seven ATM machines throughout Samoa. ANZ is the largest commercial bank, accounting for about 55% of the commercial banking assets in 2005.

Westpac's operation can be traced back to 1977, when Pacific Commercial Bank (PCB) opened for business following Westpac's acquisition of a portion of the Pacific Savings and Loans Company, in which Bank of Hawaii (BOH) had an interest since 1971. In 2001, BOH sold its 42.7% shareholding in PCB to Westpac, which increased its shareholdings to 85.4%. In 2005 it increased its holding to 94%, and now trades as Westpac Bank Samoa. It is the second largest commercial bank, just behind ANZ and accounting for about 22% of the overall commercial banking assets in 2005. In 2007, the bank had two branches and two agencies and four ATM machines.

NBS was granted a banking license in 1995 and started operating in 1996. The inception of the NBS was largely due to Luamanuvae Dick Meredith, a successful Samoan businessman, matai and entrepreneur. NBS has six branches, three in Savaii and the remaining branches in Upolu. There are ATM machines in place and further access is through other ANZ ATMs and EFTPOS facilities. It is the larger of the two locally owned commercial banks, accounting for just over 14% of all commercial bank assets in 2005.

SCB started operating in April 2003, being the last bank to enter the market and also the smallest, accounting for about 10% of total commercial banking assets in 2005. The history of the SCB is very limited, apart from the fact that it is locally owned by several local investors, and instigated by a local businessman, Ray Ah Liki, who remains the Chairman of the Board of directors.

3.7.2 Banking Regulatory Framework in Samoa

In 1998, comprehensive reform of the financial system was initiated in conjunction with the Asian Development Bank (ADB) through the Financial Sector Program Loan (FSPL) scheme. The success of this reform has earned the prestigious accolade for Samoa, as the "darling economy of the Pacific" from international institutions such as the ADB, IMF, and the World Bank (Scanlan, 2004). This is also attributed to the simultaneous fiscal and structural reforms, particularly in strengthening transparency and accountability. One of the key factors in driving for the establishment of the CBS was the need to compile and publish more reliable economic, financial information, and data on a more regular basis. Prior to that, financial information was relatively poor, meaningless, infrequent, and consequently considered to be a closely guarded secret (Scanlan, 2004). The resulting impact of this action is that all commercial banks are disclosing annual reports and the coverage is comprehensive compared to the rest in the region.

Prior to the reform, competition was virtually not existence, as the larger commercial banks dictated smaller institutions, monetary policy was implemented through a system of direct controls including: statutory reserve requirements (SRR), liquid assets reserve requirements (LAR set at 25% of deposits), interest ceilings (at least

4.5% on deposits, and no more than 12.5% interest charge on loans), and an upper limit on the amount of credit banks could lend.

Following the reform, the removal of Central Bank restrictions such as some direct control mechanisms imposed in the financial sector, aiming for a greater reliance on market mechanisms, thereby enforcing private sector activity and promoting investment in the economy, the removal of direct controls, allowing banks to lend as much as they want, setting their own level of interest rates on deposits and loans, and deciding how much credit they want to extent, LAR is phased out and foreign exchange controls were relaxed, aiming to make import payments easier, and the removal of the 1% levy on purchases of foreign exchange.

The CAR for commercial banks stands at 15%, which is significantly higher than the 8% level under the BCP and it is risk adjusted. In June 2005, the capital adequacy formula was amended, where the risk weighted category for housing loans was reduced from 100% to 50%, when the loan is fully secured by mortgage against residential property. This level of CAR could potentially undermine commercial bank lending opportunities and consequently discourage banking growth. On the other hand, holding a higher level of capital could strengthen bank stability, while leaving little room for local shareholders (especially in the two locally owned banks) to be compensated for their shareholding investment in banking shares.

The Statutory Reserves Deposit (SRD) is set at 4.8% of deposits, since June 1999, previously 5%. These reserves are held at the CBS and interest is not paid. The Liquid Assets Requirements (LAR) was phased out in May, 1999. However, commercial banks are expected to manage their day-to-day liquidity to meet daily demand and handle unexpected strains on cash flows.

Asset quality and provisional requirements are similar to the prudential requirements in Tonga and Fiji. However, there is an additional informal requirement regarding the provision for bad and doubtful debts towards non-performing loans set out by the CBS and this requirement is set at the minimum of 2% of loans and advances.

Credit exposure or loan concentration is restricted to 25%. This means, the maximum amount of credit a commercial bank can extend to a single customer is restricted to 25% of total capital.

3.7.3 Non-Traditional Banking Activities in Samoa

Commercial banks are permitted to engage in all securities activities such as securities underwriting, brokering, and deal in aspects of the mutual fund industry (2 points). Banks' participation in underwriting and selling insurance is prohibited (0 point). Banks are restricted to engage in real estate development and management (1 point). Banks' ownership of non-financial firms is permitted (2 points). Thus the overall degree of allowance to engage in non-traditional banking activities is 5 out of a possible 12. Overall, the supervisory framework is fairly flexible in terms of allowing commercial banks to engage in non-traditional banking activities. Samoan falls in the middle of neither universal like Tonga, nor separated like Fiji.

3.8 The Papua New Guinean Banking System

Land Area (km^2)	462,243
Population (2000)	5,190,000
Local Currency	Kina (PGK)

3.8.1 Banking Structure in PNG

The Bank of Papua New Guinea (BPG) is the banking supervisor since inception in 1973. Banks and licensed financial institutions (LFI) are licensed under the Banks and Financial Institutional Act 2000 (BFIA). The scope of supervision includes commercial banks, licensed financial institutions, insurance companies and pension funds.

There are currently four commercial banks: Bank South Pacific (BSP) Ltd, ANZ (PNG) Ltd, Westpac Bank (PNG) Ltd, and Maybank (PNG) Ltd and ten LFIs operating in PNG as of April 2005.

Table 3.8: PNG Commercial Banks' asset share in 2005

Commercial Banks	Total Assets 2005 (PGK m)	Total Asset 2005 (USD m)	Asset Share (%)
Bank of South Pacific	2,953	946	54.7
ANZ	1,502	481	27.9
Westpac	822	263	15.2
Maybank	119	38	2.2
TOTAL	$5,396	$1,728	100%

2005 Average Exchange Rate: USD=PGK 3.120

BSP opened in 1957 as a branch of the National Bank of Australasia. In 1993, BSP was 100% owned by National Investment Holdings Ltd. It is PNG's largest and 100% nationally owned commercial bank operating 36 branches locally and has overseas branches in Niue, Fiji and Solomon. It has been listed on the Port Moresby Stock Exchange since August 2003. BSP acquired 51% of the Papua New Guinea Banking Corporation (PNGBC) in 2001 and the rest in the April 2002. Further acquisition of the Habib Bank Ltd interests in Fiji in December 2006, and in May 2007, it took full ownership of the National Bank of Solomon Islands (NBSI). In December 2009, Colonial Bank in Fiji was also acquired.

ANZ started operating as a branch in PNG, previously operated as Union Bank, and expanded through purchases of the PNG subsidiary of Lloyd's Bank in 1990 and the Bank of Hawaii in November 2001. ANZ Banking Group (PNG) Limited is now a fully owned subsidiary of the Australian based ANZ Banking Group (PNG) Limited. Currently it has eight branches and about 33 ATM machines, and internet and telephone banking facilities throughout PNG. ANZ is the second largest, following BSP, with a total asset share of about 22% in 2005.

Westpac entered PNG through its Bank of New South Wales, as one of the first two banks to start operation in 1910 alongside the Union Bank of Australasia. It has 16 branches and nine ATM machines throughout PNG. It is the third largest commercial bank, owning just over 15% of the overall banking assets in 2005.

Maybank (PNG) Limited is a fully owned subsidiary of the Maybank of Malaysia, and was licensed in 1994 to operate in PNG. It is the smallest of the four commercial banks, had over 2% of the commercial banks assets in 2005.

3.8.2 Banking Regulatory Framework in PNG

CAR requirement has been set at 12% since October 2003. Prior to that, it had been 11% since August 2000 and both levels are above the BCP standards. The minimum tier 1 total risk based capital ratio is 8% and the leverage capital ratio is 6%.

There are two types of liquidity requirements: the minimum liquid asset ratio (MLAR) and the cash reserve requirement (CRR). The MLAR is the minimum ratio of liquid assets commercial banks are required to hold, which is a minimum of 25% of the value of customer deposits in the form of prescribed liquid assets. This current MLAR level of 25% has remained since September 1999. Prior to that, it was 20%. The CRR specifies that a bank must hold 3% of its total customer deposits in cash in a non-interest bearing account with the BPNG. This 3% level has been the case since October 2003, previously set at 5% from March 1999 to December 2002. Since June 1999, CRR deposits have been excluded from the definition of liquid assets for commercial bank.

Assets and loans classification requirements were revised in October 2003, superseding the prudential requirements set in September 2000. The former approach is similar to that of the previous three economies. The key feature of this review is the expanded five categories to include: the Pass category requires 1%, Special Mention 5%, and Substandard 25%, Doubtful 50%, and Loss at 100%. This expanded approach reflects a very cautious approach to addressing asset quality in PNG.

A bank's aggregate credit exposure to an individual counterparty or a group of related non-bank counterparties is set at 25% of the bank's capital base. Exposure to a single counterparty connected to a bank must not exceed 5% of the bank's capital base and the total credit exposure to all such counterparties must not exceed 25% of capital. This measure came into effect in October 2003, superseding the previous standard set out in June of the same year.

A striking feature of the operation of commercial banks in PNG is that in 1983, the government issued a condition that foreign parents of new locally operated banks can only own up to 49% and the remaining shares that local investors did not pick up were to be bought by the central bank (Tschoegl, 2005). However, ANZ remains wholly owned by the ANZ Group and WPC is 90% owned by the WPC Group. This stance by these two banks reflects the parent banks' unwillingness to cede control.

3.8.3 Non-Traditional Banking Activities in PNG

Commercial banks are not allowed to engage in all securities activities such as securities underwriting, brokering, and dealing in aspects of the mutual fund industry (0 points). Banks' participation in underwriting and selling insurance is prohibited (0 point), nor are they allowed to engage in real estate development and management (0 point). Banks' ownership of non-financial firms is permitted (2 points). Thus the overall degree of allowance to engage in non-traditional banking activities is 2 out of a possible 12. Overall, the supervisory framework is very restrictive in terms of prohibiting commercial banks from engaging in non-traditional banking activities. The PNG banking system is a separated banking system.

3.9 The Solomon Islands Banking System

Land Area (km^2)	28,330
Population (2000)	459,000
Local Currency	Solomon Islands Dollars (SBD)

3.9.1 Banking Structure in Solomon Islands

The Central Bank of Solomon Islands (CBSI) is the banking supervisor. It was established in February 1983 under the Central Bank of Solomon Islands Act 1976, which was amended in 1985 to strengthen the Bank's supervisory capabilities and expand its central banking functions. CBSI has been dictated by the requirements of the Financial Institutions Act 1998. The scope of supervision by the CBSI includes all three commercial banks, the Development Bank of Solomon Islands and the National Provident Fund (NBF) which came under CBSI supervision in 2002.

The three commercial banks are National Bank of Solomon Islands (NBSI), ANZ, and Westpac. NBSI is the only locally incorporated commercial bank, and the other two are operating as a branch and incorporated in Australia.

Table 3.9: Solomon Islands Commercial Banks' asset share in 2005

Commercial Banks	Total Assets 2005 (SBD m)	Total Asset 2005 (USD m)	Asset Share (%)
National Bank of Solomon Islands	410	54	43.2
ANZ	293	39	30.9
Westpac	245	33	25.9
TOTAL	$948	$126	100%

2005 Average Exchange Rate: USD=SBD 7.5299

The Commonwealth Bank of Australia (CBA) started operating in Solomon in 1951, then transferred its operations to the National Bank of Solomon Islands (NBSI) in 1985, taking over the Bank of Hawaii (BOH) in 1994, later withdrew by selling 51% of the shares to the Solomon Islands National Provident Fund (SINPF) and the remaining 49% was allocated among three trustees.

NBSI is the largest commercial bank, accounting for about 43% of the overall commercial banking assets in 2005. In August 2007, the Papua New Guinean based Bank of South Pacific (BSP) acquired full ownership of NBSI, to operate as a branch of BSP, and in return the SINPF became a shareholder of BSP, owning 4,990,771 million ordinary shares, equivalent to about 1% of BSP.

ANZ commenced operations in the Solomon in 1966 and still operates as a branch. It currently has five branches and two ATM machines. It is the second largest of the three commercial banks with just over 30% share of the overall commercial bank assets in 2005.

Westpac entered in 1985 and in 1988 acquired the operations of the Solomon Banking Corporation (SIBC). SIBC was a subsidiary of the Hong Kong and Shanghai Banking Corporation and had operated as a branch in Solomon since 1973. It is still operating as a branch. As the smallest of the three commercial banks, the asset share was just over 26% at the end of 2005.

3.9.2 Banking Regulatory Framework in Solomon Islands

The CAR for the commercial banks was set at 15% and it is risk weighted. However, this level may vary for a newly established commercial bank or if perceived by the CBSI to have an excessive concentration of credit risk or other significant risk exposures. This requirement was revised to 10% since 2003. The commercial banks have been well capitalised throughout and this is reflected by their overall actual CAR being about 20% for the entire period.

CBSI has a minimum liquidity requirement currently set at 7.5%. It was previously set at 7% and it is held at the CBSI and compensated at 3% per annum. This requirement is more of a statutory deposit requirement as opposed to the common liquidity requirements. Aggregate liquid assets to totals assets for all commercial banks are disclosed by the CBSI alongside the ratio of liquid assets to short term liabilities (total demand deposits).

Asset quality and provisional requirements have the common three categories of substandard, doubtful and loss and the required provisions are 20%, 50%, and 100% respectively.

CBSI has a restriction on large credit exposures: a limit of 25% of total capital on a financial institution's exposure to an individual counterparty or group of counterparties. However, exposures to the Government are not subject to this restriction. This exception is similar to the situation in Tonga and in could potentially threaten bank stability.

3.9.3 Non-Traditional Banking Activities in Solomon Islands

Commercial banks are restricted from engaging in all securities activities such as securities underwriting, brokering, and dealing in aspects of the mutual fund industry (1 point). Banks' participation in the insurance industry, such as engaging in underwriting and selling insurance is restricted (1 point). Banks are prohibited to engage in real estate development and management (0 point) and ownership of non-financial firms is also prohibited (0 points).

Thus the overall degree of allowance to engage in non-traditional banking activities is 2 out of a possible 12. Overall, the supervisory framework is very restrictive in terms of prohibiting commercial banks from engaging in non-traditional banking activities. Solomon Islands banking system is a separated banking system.

3.10 The Vanuatu Banking System

Land Area (km^2)	12,190
Population (2000)	191,700
Local Currency	Vatu (VUV)

3.10.1 Banking Structure in Vanuatu

The Reserve Bank of Vanuatu (RBV) is the banking supervisor. It was established in 1989. Prior to that, it operated as the Central Bank of Vanuatu (CBV) starting in 1981 following the country's political independence from Great Britain and France in July 1980. RBV is guided by the Financial Institutions Act 1999 and the International Banking Act 2002. The scope of supervision includes four domestic and seven international banks, insurance companies, pension funds, credit unions, and the Corporative and Savings Societies exceeding the threshold of VUV10 million. In 2002, the RBV also taken responsibility for the supervision of offshore banks, previously conducted by the Vanuatu Financial Services Commission.

The commercial banks operating in Vanuatu include: ANZ Bank (Vanuatu) Limited, Westpac Banking Corporation, National Bank of Vanuatu, owned by the Vanuatu government, and the European Bank Limited, wholly owned by the European Capital Holding Corporation, and registered in Delaware USA. The European Bank does have a domestic banking license but does not receive deposits or make loans locally, so is excluded from the research.

Table 3.10: Vanuatu Commercial Banks' asset share in 2005

Commercial Banks	Total Assets 2005 (VUV m)	Total Asset 2005 (USD m)	Asset Share (%)
ANZ	32,529	298	60.2
Westpac	16,416	150	29.3
National Bank of Vanuatu	5,133	47	9.5
TOTAL	$54,078m	$495	100%

2005 Average Exchange Rate: USD=VUV 109.25

ANZ entered in 1971 and in 1985, it acquired the operations of Barclays Bank. In 2001, it acquired the Bank of Hawaii's 95% stake in banque d'Hawaii (Vanuatu). It is the largest of the three commercial banks in terms of asset size. In 2005, it accounted for just over 60% of overall commercial bank assets.

WPC entered in 1971 as the Bank of New South Wales and in 1988, it acquired HSBC's operations. As the second largest commercial bank, it had an asset share in 2005 of about 30% of the overall commercial bank assets.

In 1991, the government established NBV and in 1998 it took over the remaining assets of the Development Bank of Vanuatu. At December 2006 it had about 21 branches throughout Vanuatu. As the smallest of the three commercial banks, the asset share was just under 10% in 2005.

3.10.2 Banking Regulatory Framework in Vanuatu

The CAR was somewhat different. Banks were required to maintain a minimum capital amount of VUV200 million and not the typical capital adequacy ratio. In April 2003, this was reviewed and the traditional risk weighted 8% requirement was adopted on both a consolidated and stand alone basis, of which at least 4% should be tier 1 capital and consistent with the BCP.

Statutory Reserve Deposit (SRD) is set at 10% of the total deposits and 50% of the foreign currency deposits and held at the RBV. It was first introduced in 1998 and in 1999 the foreign deposit requirement was added to the SRD. Commercial Banks are required to meet this requirement on a daily averaging basis. In that, going below the SRD is allowed if they meet the requirement on average during the holding period.

Interest is not paid on cash but paid on any securities received at a rate compatible with the market.

The liquid asset requirement is set at 12% since July 2004, was previously set at 15%. Banks are required to hold a minimum of 12% of liabilities in specified liquid assets at all times. Liquid assets include notes and coins, balances with the RBV excluding statutory reserve deposits, RBV notes, other central government securities, and other assets approved by the RBV.

Asset quality and provisional requirements remain at the three categories of substandard, doubtful and loss and the required provisions are 20%, 50%, and 100% respectively.

The maximum exposure limits to a single customer or group is 25% of capital in relation to nonbank and non government counterparties. This requirement further expands the concern previously noted in Tonga and Solomon. The government exclusion from this credit exposure is potentially a concern but in addition to that, exposure by other banking firms could equally increase the contagion effect and the stability of the overall banking system and the rest of the economy. Also, the RBV approval is required prior to any commercial (or its subsidiaries) decision to invest in equity, particularly if the investment surpasses 25% of the bank's capital base.

All commercial banks (except Westpac Vanuatu) are required to comply with compulsory public disclosure requirements and to submit an annual audited financial statement to the RBV.

3.10.3 Non-Traditional Banking Activities in Vanuatu

Commercial banks are permitted to engage in all securities activities such as securities underwriting, brokering, and dealing in aspects of the mutual fund industry (2 points). Banks' participation in the insurance industry, such as engaging in underwriting and selling insurance is permitted (2 points). Banks are restricted to engage in real estate activities such as engaging in real estate development and management (1 point). Banks' ownership of non-financial firms is permitted (2 points).

Thus the overall degree of allowance to engage in non-traditional banking activities is 7 out of a possible 12. Overall, the supervisory framework is fairly flexible in terms of allowing commercial banks to engage in non-traditional banking activities. The Vanuatu banking system is a universal banking system.

3.11 Chapter Summary

This table provides a snapshot of the variations in prudential requirements across the region.

Table 3.11: PICs Prudential Requirements for 2000 to 2006

	Tonga	Fiji	Samoa	PNG	Solomons	Vanuatu
CAR	15% & 8%	8%	15%	11% & 12%	15% & 10%	8%
LAR	5%	None	None	25%	None	15% & 12%
SRD	15% & 12.5%	6% & 7%	4.8%	3%	7.5%	10% & 50%*
Asset Quality & Provisions (%)	Standard (0) Special (0) Sub-ST (20) Doubtful (50) Loss (100)	Standard (0) Special (0) Sub-ST (20) Doubtful (50) Loss (100)	Sub-ST (20) Doubtful (50) Loss (100)	Pass (1) Special** (5) Sub-ST (25) Doubtful (50) Loss (100)	Sub-ST (20) Doubtful (50) Loss (100)	Sub-ST (20) Doubtful (50) Loss (100)
Credit Exposure	30%	25%	25%	25%	25%	25%
NBA**	7/12	2/12	5/12	2/12	2/12	7/12

Sub-ST category refers to Substandard, * 10% for local deposits and 50% for foreign deposits, ** Special stands for the special mention category, and NBA** is the non-banking activities.

CAR in Fiji maintains the BCP (8%) level throughout; Tonga and Vanuatu join in later; Solomon is 10% dropping from 15%; PNG increases to 12% from 11%; and Samoa maintains a very high level at 15%.

Liquidity requirements are not formalised in Fiji, Samoa and the Solomons Islands, and the highest is 25% in PNG, followed by 12% in Vanuatu and 5% in Tonga. SRD is highest in Tonga, followed by Vanuatu; Fiji is marginally behind the Solomons and Samoa, and lowest in PNG.

Asset quality and provisional requirements are fairly consistent among the countries with the notable exception being PNG, where the first two categories require provisional reserve requirements reflecting a very cautionary approach to credit risk.

Credit exposure to counterparties is almost consistent across the six countries with the exception of Tonga. However, the exclusion of government agencies from this exposure in Tonga, Solomon and Vanuatu is also a concern. Vanuatu's exclusion of the other banks could potentially compromise the stability of the banking system and the rest of the economy.

Finally, banking supervisors' stances in permitting the commercial banks' engagement in non-traditional banking activities vary significantly. The most flexibility is applied in Vanuatu and Tonga scoring 7 out of the overall 12. Samoa follows at 5 and Fiji, PNG and Solomons are very restrictive at 2. Fiji, PNG, and Solomons reflect the features of the separated banking systems, Tonga and Vanuatu fall into the universal banking category, and Samoa is in the middle.

Chapter 4: Data & Methodology

4.1 Data Collection Process

The primary data are sourced from the financial statements for all commercial banks operating in the six countries. The disclosure framework among the regions varies significantly and poses the challenge of standardising all financial statements in a comparable manner before data analysis. This standardization process enables the comparison of several key banking characteristics and the identifications of necessary input and output variables for the efficiency measurements.

A notable exception in this process is the availability of the commercial banks' financial statements in Fiji, as they are all disclosed by the Reserve Bank of Fiji (RBF) website alongside other non-bank institutions currently operating within the scope of the RBF supervisory framework. The format of these financial statements provides the template for the rest of the commercial banks in the remaining five countries.

The financial statements from Samoa and PNG commercial banks are disclosed in a full annual report format and with the help of central bank officials, the data were successfully obtained. Financial statements from Solomon are less comprehensive compared to the other three but the efforts of central bank officials made a big difference.

The first main problem encountered in this data collection process occurred in Tonga, regarding the ANZ Tongan operation. This bank was only required to disclose financial statements publicly from 2005 and since this study also needs access to 2000 – 2004, a request was made directly to the head of ANZ's operation in Tonga, but, unfortunately it was declined. A subsequent request was submitted directly to the office of the head of ANZ Pacific Banking in Melbourne, Australia, despite his willingness to help, it was refused. The annual reports for WPC were obtained directly from its office in Tonga. The Malaysian Banking Finance (MBF) Bank Limited financial statements were provided by the National Reserve Bank of Tonga (NRBT).

In Vanuatu, the local bank, National Bank of Vanuatu (NBV) is the only commercial bank that responded and provided financial statements. Westpac is operating as a branch and not required to disclose financial statements publicly.

Therefore, the overall dataset is 138 representing a full dataset for all commercial banks from Fiji (35), Samoa (25), PNG (28), and Solomon (28). From Tonga, 16 financial statements were obtained, but the remaining 5 from ANZ are not accessible. We have six financial statements from the NBV in Vanuatu.

The secondary data are mostly sourced from the central banks' annual reports, local government statistics agency and other foreign sources such as the IMF, World Bank, and the Asian Development Bank.

4.2 Primary Data

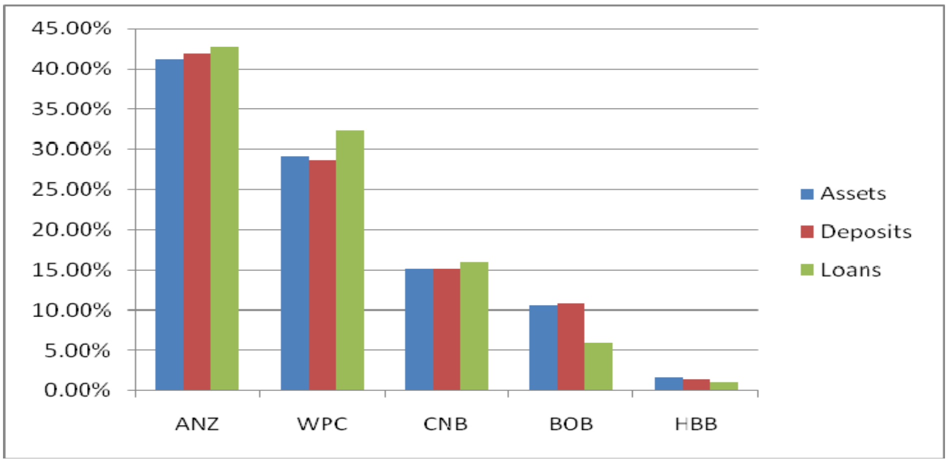
The primary data from the commercial banks are discussed relative to five key categories: market share, annual growth, intermediation process, asset quality, and a comparison between interest and non-interest items. These five categories provide a foundation for the explanation of variation in banking efficiencies. Vanuatu is not included in this discussion due to the unavailability of data.

4.2.1 Market Share

The rationale for this section is justified by the notion that market share is associated with better economic performance (Berger et al, 2004). The degree of competition within each of the PICs is the banks' market share (the annual average share between 2000 and 2006). For instance, if one commercial bank is very dominant in both the deposits and loan market then it could signal a monopolistic situation.

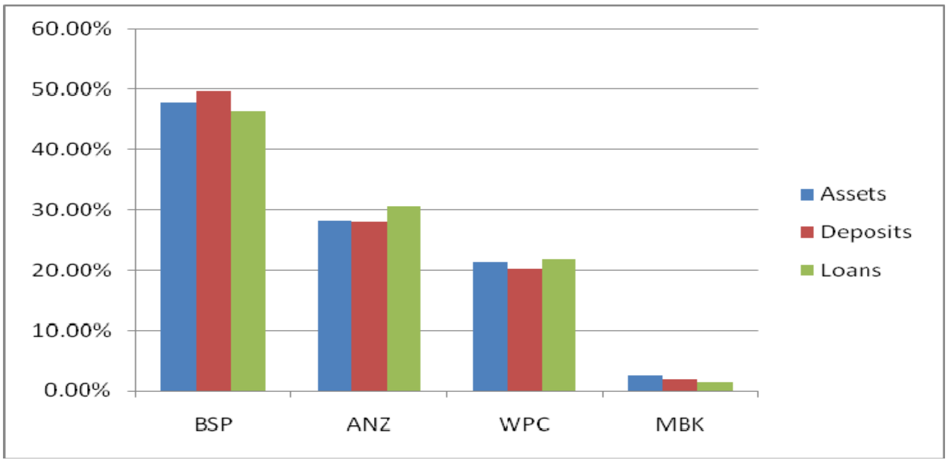
On the other hand, if all commercial banks have a fairly even share of these markets, we would expect a more competitive local banking environment, an important determinant of bank efficiency (Bos & Schmiedel, 2007). However, this is unlikely since the number of commercial banks is small, and market structure is not an adequate indicator of banking competitiveness (Beck & Hesse, 2009).

Figure 2: Average Market Share for Assets, Deposits and Loans in Fiji



In Fiji, ANZ dominance is prominent, having expanded when it took over the operation of the Bank of Hawaii in 2002. ANZ share in the loans market continues to grow and peak in 2005 at around 45%. WPC is steady in all three but peaking in 2004. CNB makes much progress in increasing its market share, deposits and loans share almost doubled between 2000 and 2006. BOB remains fairly steady in assets and in the deposits market, marginally losing ground in the loan market, their share dropping to 4% in 2006 from over 6% in 2000. The smallest bank HBB steadily losing ground in both deposits and loans market share. It was absorbed by the PNG-based Bank of South Pacific in December 2006, later acquired CNB in 2009. The obvious trend in market share is the increasing prominence of the three largest banks, while CNB outpaces both ANZ and WPC. The two smallest banks lost ground, hence, competition is driven by the performance of CNB.

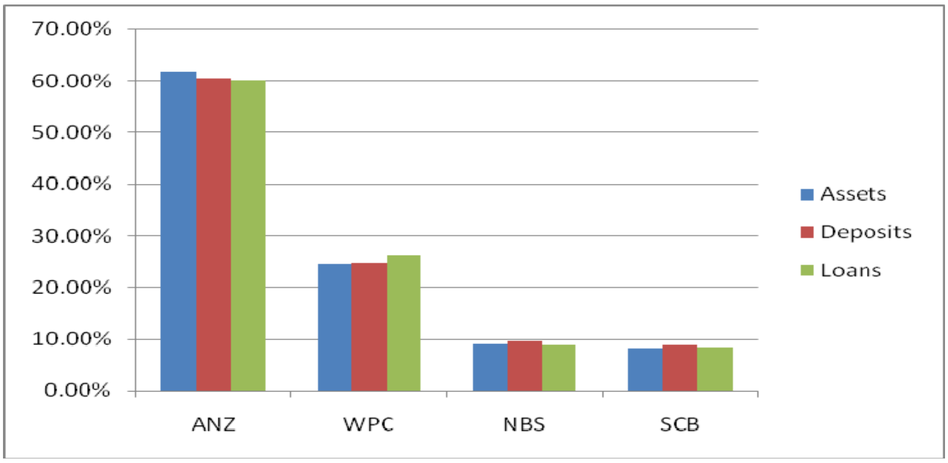
Figure 3: Average Market Share for Assets, Deposits and Loans in PNG



The market structure in PNG is dominated by the fast growing BSP in assets and deposits market: starting at around 35%[6] in 2000 and ends at 60% by 2006. This trend continues into the loans market but to a lesser extent, finishing at 50% by 2006 compared with a 35% in 2000. ANZ's market share is fairly stable in all three variables at around 30%. WPC seems to be the least successful in asset's share dropping to 14% by 2006 compared to a 35% share in 2000. This trend is repeated in the deposits market but marginally more successful in the loan market dropping to only 20% compared with over 30% in 2000. The smallest bank MBK is struggling for market share, where its minimum share in all three variables occurs in 2006.

The degree of competition in the banking industry is dominated by BSP, strengthened by its acquisition of the Papua New Guinea Banking Corporation (PNGBC) in 2002, and reflected by the sudden increase in its market share in 2002. However, ANZ's acquisition of the Bank of Hawaii's operation in 2001 had a short term effect in its increasing market share. The two Australian owned banks appear to exert little influence over BSP, and MBK is making very little difference.

Figure 4: Average Market Share for Assets, Deposits and Loans in Samoa



The entrance of the Samoa Commercial Bank (SCB) in 2003 triggered the restructuring of the local market share in Samoa resulting in ANZ losing a lot of dominance and the increasing gain by the two small locally owned banks. This increasing competitive pressure is most evident in ANZ's decreasing dominance in

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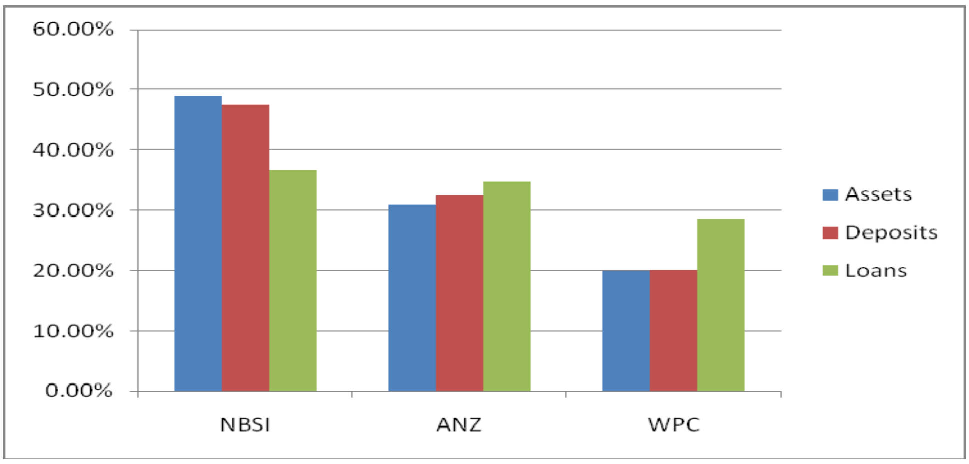
[6] This proportion excludes the discontinued operations of PNGBC and BOH and their exclusion is based on the unavailability of banking data, although their inclusion could inevitably influence the market share of the other banks.

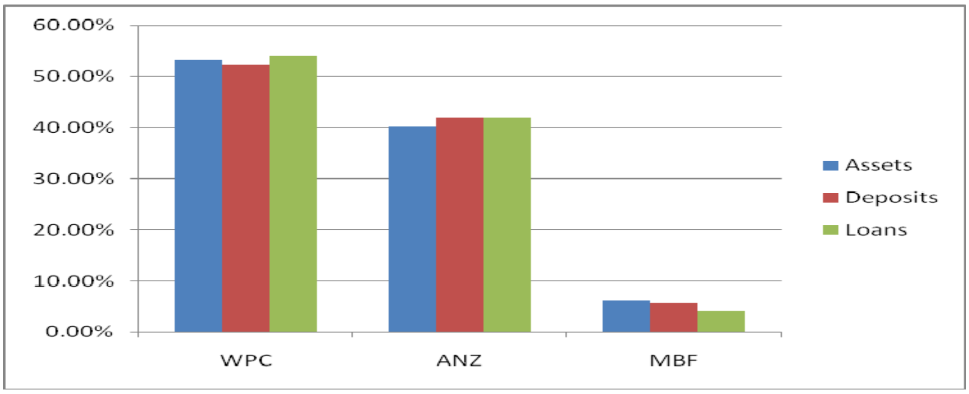
the local banking market from about 70% in 2000 to 50% by 2006 in all three variables. WPC seems to steady at around 25% in all three variables, while the two locally owned commercial banks: NBS and SCB are gaining grounds in assets size, deposits and loans.

Figure 5: Average Market Share for Assets, Deposits and Loans in Solomon Is



For Solomon Is, the changes in the market share for the commercial banks are quite interesting. NBSI was dominant in all three variables in 2000 by about 50% and by 2006 it lost about 10% in both asset and deposits and 20% in the loans market. ANZ is steady in both asset and deposit at around 30% but lost 10% in the loan market, dropping to 30% in 2006 from over 40% in 2000. The most successful story is the increasing share of the WPC in assets from 15% in 2000 to 25% by 2006, driven by a 10% increase in the deposit market and a 30% gain in the loan market to 40% by 2006 compared with just over 10% in 2000. In 2003 alone, WPC doubles its loan portfolio. Therefore, competition in the banking industry is most evident in the loan market.

Figure 6: Average Market Share for Assets, Deposits and Loans in Tonga



The distribution of market share in Tonga across the three commercial banks is heavily compromised by the unavailability of the financial statements for ANZ for the first five years: 2000 – 2004. However, the last two years suggest that Westpac and ANZ dominate both deposits and loans markets by over 50% and 40% respectively and MBF pick up the rest with more than 5% share of the deposits market and less than 5% in the loan market. A small trend appearing in 2006, WPC's dominance in both deposits and loans markets are marginally reduced, MBF loses ground in both markets, and ANZ is gains in both markets. The degree of competition in the banking market in Tonga is driven by the two large banks. MBF is too small to exert any competitive pressure.

4.2.2 Annual Growth Rate

The inclusion of the annual growth rate in this discussion is based one of the objectives of banking supervision to promote sustainable growth. In the context of small economies, annual growth rate is critical in encouraging growth in the wider economy. Annual growth rate in assets and loans are presented in the local currency. It is unweighted and the average differs from the overall banking system growth rate.

Table 4.2A: Commercial Banks' Average Asset (AGR) and Loan (LGR) Growth

Fiji	ANZ	WPC	CNB	BOB	HBB	Average
AGR	8.11%	9.72%	14.44%	9.26%	-6.39%	7.03%
LGR	12.38%	13.07%	22.83%	4.13%	-21.79%	6.13%
PNG	BSP	ANZ	WPC	MBK		
AGR	41.50%	21.69%	7.79%	14.22%		21.30%
LGR	29.75%	14.34%	10.72%	9.50%		16.08%
Samoa	ANZ	WPC	NBS	SCB		
AGR	2.92%	8.98%	22.47%	58.63%		23.25%
LGR	11.88%	14.24%	31.09%	74.64%		32.96%
Solomon	NBSI	ANZ	WPC			
AGR	11.56%	15.99%	29.62%			19.06%
LGR	14.38%	22.98%	50.25%			29.20%
Tonga	WPC	ANZ	MBF			
AGR	12.14%	14.41%	9.60%			12.05%
LGR	17.95%	12.87%	5.96%			12.26%

The average annual growth for all commercial banks over the period in Fiji is compromised by the negative growth for HBB, resulting in an average of 7% for assets and 6% for loans. Both figures are significantly lower compared to other countries. A striking feature is the superior growth of CNB, dominating the industry in both variables. It is followed by WPC and ANZ while the smallest bank HBB struggles for growth in both variables.

The average growth for all commercial banks in PNG is dominated by the superior average growth in assets. This trend is largely due to the rapid growth by the largest bank: BSP, which is a direct consequence of its acquisition of the PNGBC in 2002, bear in mind the discontinued operations of PNGBC and the Bank of Hawaii is not included. However, ANZ and WPC both experience good growth and the smallest bank: MBK is not crowded out and 14% growth in asset and 10% in loans.

Samoa dominates the average annual growth in both assets and loans. However, this dominance is slightly misguided, since this superior growth is attributed to the entrance of the locally owned bank, SCB in 2003 and its respective 60% average for assets and 75% for loans would not be possible otherwise under normal circumstances. However, NBS is also experiencing superior growth but not quite to the same extent as SCB. Together, the two smallest but locally owned banks clearly dominate their larger foreign-owned counterparts.

The final feature of growth in Samoa is the decline of the largest commercial bank: ANZ. The average asset growth of 3% is further compounded by a bigger struggle to attract deposits but fortunately, its presence remains fairly modest with an average growth of 12% in the loan market compared to the industry average of 16%.

The average annual growth for all commercial banks in Solomon over the period is dominated by the superior growth in loans with an average of 30%, followed by assets at 20%. The main feature is the outstanding growth by the smallest commercial bank: WPC. Its average of 50% for growth in loans is due to a 110% jump in 2003[7] coinciding with the arrival of the Regional Assistance Mission to Solomon (RAMSI) followed by an annual average of around 50% in the last three years, which is a contrast to its negative -3% growth in 2001.

[7] In July 2003, RAMSI was an Australian- led peacemaking effort from nine regional countries with over 2000 police and military personnel. Perhaps, financing was significantly channelled through WPC.

Finally, in Tonga, the average growth for both variables is fairly even at 12%. WPC average asset annual growth rate of 12% due to its superior share in the deposits and loans markets, and an average annual growth rate of 20% in the latter. On the other hand, MBF struggles early for growth in assets and the loan market but settling with a modest 10% average for assets growth and 6% for the growth in its loan portfolio.

4.2.3 Intermediation Process

The intermediation process focuses on the intermediation by the commercial banks and aims to identify the impact of prudential requirements in the intermediation process. Consequently, customer deposits and purchased funds provide the basis for loan activities. Hence, the degree of intermediation is a function of both SRD and liquidity requirements. SRD is held at the central bank and liquidity requirements are held by the commercial banks in liquid assets while forgoing lending opportunities and are more likely to return lower interest from local government debt instruments.

The GL/TA ratio reflects the proportion of the gross loan (GL) portfolio to total assets (TA). In the GL/DAL, the denominator is the remaining deposits available for loans (DAL) after the SRD. A high percentage reflects strong intermediation and vice versa. This proxy is also expected to exceed 100% reflecting the fact that the current loan portfolio is based on loans from the current and previous years but it can also signal some degree of over lending, which is subjected to capital requirements.

Table 4.2B: Commercial Banks' Average Intermediation

Fiji	ANZ	WPC	CNB	BOB	HBB	Average
GL/TA	68.40%	72.08%	68.39%	35.48%	46.56%	58.27%
GL/DAL	83.53%	86.24%	85.16%	41.69%	73.83%	80.10%
PNG	BSP	ANZ	WPC	MBK		
GL/TA	37.27%	41.83%	38.28%	26.69%		36.02%
GL/DAL	43.57%	53.42%	51.17%	45.93%		47.34%
Samoa	ANZ	WPC	NBS	SCB		
GL/TA	66.10%	72.48%	68.87%	71.81%		68.69%
GL/DAL	87.95%	93.85%	101.81%	95.86%		90.27%
Solomon	NBSI	ANZ	WPC			
GL/TA	28.07%	43.81%	53.61			41.83%
GL/DAL	46.76%%	43.05%	65.52%			51.78%
Tonga	WPC	ANZ	MBF			
GL/TA	67.78%	75.51%	52.30%			65.20%
GL/DAL	104.68%	106.78%	80.03%			97.16%

The GL/TA ratio in Fiji is fairly similar for the three largest banks: ANZ, WPC, and CNB at around 70% compared to HBB at 47% and 35% for BOB. This trend continues to the intermediation process where the GL/DAL ratio is around 85% for the three large banks followed by HBB at 74% and BOB at 42%.

The inclusion of the CAR in this discussion is based on the notion, if a bank's level of CAR is well beyond the minimum standard, it is suggesting there is more room for intermediation. The average CAR for the three large banks are just over 10% compared to the minimum CAR of 8%. This observation could well suggest that the three large banks are most likely to be operating at a relatively scale efficient level compared to the last two banks. As a consequence, we should expect HBB and BOB to be relatively scale inefficient, reflected by their relatively higher CAR and suggesting there is some room for more intermediation.

The GL/TA ratio in PNG is 36% for the industry, which is very low compared to the rest of the countries. The GL/DAL ratio is also relatively low at 47% reflecting that intermediation process can be improved significantly. However, demand for loans is considerably weak. In 2005, mining companies were allowed to borrow from the commercial banks. Furthermore, this phenomenon is also a consequence of the liquidity requirements imposed by the central bank at 25%. On the other hand, this observation could also suggest limited scope for lending opportunities.

For Samoa, the GL/TA ratio is fairly similar to all four banks at around 70%. However, higher loan loss provision requirements place ANZ and NBS at 64% of net loans to total assets compared to WPC and SCB at 70%. The GL/DAL ratio is highest for NBS at 102%[8], followed by SCB at 96%, WPC at 94% and the lowest is ANZ at 88%. This ratio confirms the earlier sections where the two locally owned banks are quite competitive in the intermediation process compared to their larger foreign owned counterparts.

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[8] This percentage suggests that gross loan exceeds the deposit available for loans. This is not unusual since the portfolio is a reflection of the accumulation of loans issued in the current and previous years. On the other hand, this could also suggest some degree of excessive lending.

In Solomon, the GL/TA ratio is marginally over 40% and suggests that perhaps, demand for loans may be as weak as in PNG. This ratio is lowest for NBSI below 30%. However, greater intermediation for ANZ at 43% and the highest is WPC at over 50%. This observation confirms WPC dominance in the loan market in the previous section.

The intermediation process in Tonga is fairly strong and reflected by the industry's average of 65%, which is second only to Samoa. ANZ dominates the intermediation, reflected by its superior GL/TA ratios. WPC is more successful in issuing loans, shown by its GL/DAL ratio reaching 112% in 2005 and 113% in 2006. On the other hand, MBF is struggling to issue loans and reflected by its GL/DAL ratio averaging at 80%. However, it improves to 91% in 2005.

Finally, the intermediation across the region is dominated by Samoa and Tonga, followed by Fiji. PNG and Solomon are significantly lower and suggesting that perhaps the demand for loans are relatively weak.

4.2.4 Asset Quality

The inclusion of asset quality is based on the dual role of banking supervision: promoting growth (previously discussed in section 4.2.2) and bank stability, which is the essence of asset quality. Sinkey (2002) cites a study of bank failure suggesting that poor asset quality is the most important contributing factor in 98% of failed banks. Mishkin (2001) defines asset quality as an indicator for future losses and affects other areas of banking examination, which must be considered in light of their adequacy to absorb anticipated losses. Similarly, the previous study cited by Sinkey identifies eight loan practices as key determinants of poor asset quality: liberal lending practices; excessive financial statement exceptions; over lending (discussed in section 4.2.3); excessive collateral documentation exceptions; collateral-based lending; excessive growth (section 4.2.2), relative to management, staff, systems, and funding; unwarranted concentrations of credits; and out-of-area lending.

The exact measure or proxy for asset quality is most challenging here, as the disclosure framework and the availability of such data dictate it. This is confounded by the disclosure variation between commercial banks within each country and the variation from across countries. However, two key ratios are used to examine asset quality here: the proportion of loan provisions to gross loans (PDD/GL) and both items are obtained from the Balance Sheet; and loan losses (the expense item from the Income Statement) against loan provisions (BDD/PDD). The former is used to signal future loan losses (although it has a current loan losses component, as discussed in chapter 3) and the latter accounts for both annual loan losses and annual change in loan provisions.

The PDD/GL is relatively straightforward, while the BDD/PDD is more challenging in terms of being consistently applied to all commercial banks due to the differences in accounting reporting standards. For instance, BDD is normally disclosed through two separate items: actual loan losses, and the change in loan provisions. In some cases, the two items are consolidated as a single item, in other cases, the consolidated item is further adjusted against loan recovery, and finally, neither item is disclosed but one can assume that both are buried under operating expense. For the sake of consistency, the term bad and doubtful debt expense (BDD) is used instead of current loan losses.

Table 4.2C: Commercial Banks' Average Asset Quality

Fiji	ANZ	WPC	CNB	BOB	HBB	Average
PDD/GL	3.73%	2.29%	3.10%	0.86%	21.00%	6.20%
BDD/PDD	20.08%	16.57%	40.80%	49.98%	15.68%	28.62%
PNG	BSP	ANZ	WPC	MBK		
PDD/GL	4.45%	4.25%	2.40%	11.65%		5.69%
BDD/PDD	32.95%	23.32%	4.45%	24.73%		21.36%
Samoa	ANZ	WPC	NBS	SCB		
PDD/GL	2.73%	3.89%	7.82%	2.85%		4.32%
BDD/PDD	18.94%	30.76%	21.17%	72.97%		35.96%
Solomon	NBSI	ANZ	WPC			
PDD/GL	4.90%	3.54%	6.00%			4.81%
BDD/PDD	-9.03%*	17.28%	44.04%			17.43%
Tonga	WPC	ANZ	MBF			
PDD/GL	3.69%	5.00%	24.03%			10.91%
BDD/PDD	11.47%	15.38%	28.86%			18.57%

*This negative item reflects the excess of loss recoveries over loan losses for the period.

The PDD/GL in Fiji increases steadily from 2000 to 2004 (7.32%) before descending to 6.03% in 2006 and the average is 6.20% for the industry over the entire period. HBB has the highest PDD/GL ratio at over 20% while BOB has less than 1%. Surprisingly, the BDD/PDD ratio is suggesting that HBB experiences the least loan losses throughout the period (zero losses for 2003 to 2006 reflecting a 20% reduction in GL/TA, following high losses in 2000 to 2002) while BOB and CNB experience the most. WPC has the superior asset quality: its PDD/GL ratio is second lowest to BOB and the average BDD/PDD ratio is also second lowest to HBB. On the other hand, BOB is considered to have the worst asset quality: the lowest average loan provisions and the highest proportion of loan losses for the period.

Addressing asset quality is most comprehensive in PNG compared with the rest, as discussed in chapter 3. The PDD/GL ratio is suggesting that MBK is well ahead at 12%, BSP and ANZ at around 4%, while WPC is lowest at over 2%. In this context, we could lean towards MBK to have the poorest asset quality and WPC to be the best. However, the BDD/PDD ratio seems to reflect a different story and suggesting BSP has the least asset quality indicating a 32.95% ratio and WPC superiority is maintained. The BSP poor asset quality is mainly driven by its performance in 2004 where its level of bad debt exceeds its overall provisions for loans. However, this is probably a consequence of tidying up the PNGBC's loan portfolio following the introduction of the new asset quality framework in October 2003 (section 3.8.2).

The disclosure of asset quality is more detailed in Samoa. The annual loan losses are disclosed as bad debt expense and the allowance for credit impairment (ACI) appear separately in the Income Statement. The average PDD/GL ratio ranges from 9% for NBS to 3% for both ANZ and SCB. The ACI/PDD ratio is highest for SCB reflecting its entrance in 2003 where loan provisioning and ACI are identical. The only other obvious feature is WPC's BDD/PDD ratio, it is 31% compared to about 19% for ANZ and 21% for NBS. Therefore, asset quality is most superior for ANZ and arguably worst for SCB.

Measurement of asset quality in Solomon Island is significantly compromised by the unavailability of the relevant data. However, NBSI average loan losses provisioning is higher than ANZ despite ANZ's higher loan losses. The negative BDD/PDD ratio for

NBSI reflects the inclusion of loan recoveries in this item. WPC's average BDD/PDD of 44% is unusually high but driven by a 130% ratio in 2000 and the increasing loan growth in the last four years.

In Tonga, WPC's provisions for loan losses are four times lower compared to MBF and suggesting that WPC is anticipating less future loan losses. The proportion of bad debt expense to the loan provisions is also higher for MBF than WPC. Asset quality seems to be a major concern for MBF compared to WPC, although MBF is better equipped to counter future loan losses compared to WPC. In combining the two ratios, MBF's higher PDD/GL ratio is a function of its higher BDD/PDD ratio. However, MBF has a very small loan portfolio.

4.2.5 Comparable Non-Interest Expense and Non-Interest Income

The final component of this section is a direct comparison between interest and non-interest items. Regional interest income, interest expense, and interest margin are discussed later in section 4.3.1. Interest income is compared against non-interest income and the average contribution of each item towards total income. Similarly, interest expense is compared against non-interest expense and their respective average contribution towards total expense. The following table presents only the percentage of non-interest expense (NIEX) over operating expense; hence the percentage of interest expense is 1 – NIEX. This is also applied towards non-interest income (NIINC) and interest income.

The purpose for this comparison is an offshoot of the first three items: market share, annual growth rate, and the intermediation process. It provides a comparable platform for the cost structure of the commercial banks. This could in turn signal the role of interest rates in the efficiency of commercial banks and the intermediation process.

Another potential prospect of this section is to investigate the difference between separated and universal banking in the context of smaller economies. For instance, countries that are operating under a universal banking environment are likely to generate more proportion of operating revenue from non-interest income sources. On the other hand, a separated banking system should generate most of its income sources from interest income through the loan portfolio. However, this assumption does not always hold since interest income can be sourced from local government debt instruments, although this distinction is often difficult to be applied consistently due to the variation in the disclosure framework across the region.

Table 4.2D: Commercial Bank's Average Non-Interest Items

Fiji	ANZ	WPC	CNB	BOB	HBB	Average
NIEX	86.63%	73.82%	82.06%	69.74%	79.30%	78.31%
NIINC	44.82%	32.97%	33.72%	27.10%	36.22%	34.97%
PNG	BSP	ANZ	WPC	MBK		
NIEX	69.91%	63.50%	68.98%	58.94%		65.33%
NIINC	30.42%	46.05%	47.03%	26.37%		37.47%
Samoa	ANZ	WPC	NBS	SCB		
NIEX	67.78%	54.69%	74.18%	64.60%		65.40%
NIINC	42.25%	36.05%	38.65%	29.76%		37.51%
Solomon	NBSI	ANZ	WPC			
NIEX	90.25%	89.65%	69.04%			82.66%
NIINC	50.16%	57.94%	52.49%			51.81%
Tonga	WPC	ANZ	MBF			
NIEX	67.18%	75.12%	64.48%			65.83%
NIINC	47.82%	65.24%	33.42%			40.62%

The industry average for NIEX over total expenses in Fiji is 78%. However, the variation across banks is evident ranging from the ANZ at almost 90% to BOB at 70%. Fiji is rated (section 3.6.3) as a separated banking system. In that context, we are expecting interest income to dominate non-interest income and this is certainly confirmed by the industry's share of interest income being dominant at 65% of total income.

The percentage of NIEX over total expense in PNG for the industry is 65%. However, the variation is fairly even across all banks, where BSP and WPC have 70% compared with Maybank at 60%. PNG is rated (section 3.8.3) as a separated banking system and the industry's proportion of interest income to total income is 63%, however, it is worth noting that some of the interest income data are sourced from the commercial banks holding of government debt securities, although the actual proportion is unclear.

The industry average for NIEX in Samoa is 65% and similar to PNG. Samoa is rated (section 3.7.3) as neither separated nor universal banking system but somewhat in the middle. However, the industry's interest income accounts for over 60% of total income and suggests that Samoa is functioning as a separated banking system as opposed to an universal banking system. While this NIINC proportion is similar to PNG, Samoan banks do not hold as much government debt securities compared to the PNG commercial banks, and bear in mind that Samoa has no formal liquidity requirement compared with PNG at 25% of total deposits.

The NIEX industry average for Solomon is 83%, which is the highest among these countries. The variation among the commercial banks is quite evident in NBSI and ANZ, both at around 90% and WPC trailing by 20% at 70%. Solomon is rated (section 3.9.3) as separated banking system and the industry's proportion of interest income to total income is 48%. This proportion is unusual as we expect a separated banking system to have a larger share of NIINC. However, the trend through time is suggesting that the industry is moving towards non-interest based income sources.

For Tonga, NIEX accounts for 65% of total expense for all banks and it is fairly similar to PNG and Samoa. Tonga is one of two countries where the banking system promotes universal banking (section 3.5.3). In that context, we expect non-interest income to dominate interest income. This is indeed the case with ANZ reflecting the highest share of non-interest income sources at 65%. WPC reflects an even share between the two main income sources and evident from its higher proportion of loans portfolio (its average GL/TA is the highest for all commercial banks in the region, section 4.2.3). MBF is the opposite compared with the other two banks and not entirely unusual since it is the smallest bank.

The resulting summation of this section is consistent with the expectation, and previously discussed in chapter 3. Universal banking has little influence in the operation of the commercial banks in these small economies, despite the local banking supervisor's prudential position. This is most likely due to the obvious lack of financial deepening or the unavailability of other non-loan based opportunities. This conclusion warrants no further investigation of universal banking and its potential impact on bank efficiency. However, for larger developed economies, the impact of universal banking on efficiency may well be an important cause of action to pursue.

Finally, the largest commercial bank in Fiji, PNG, and Solomon is also dominating the local market share and the highest proportion of NIEX (or lowest IEX). This trend is absent for the largest bank in Samoa and Tonga. In Samoa, NBS has the highest local NIEX and its average GL/DAL ratio is highest for all banks. Similarly, ANZ has the highest local NIEX in Tonga and coincidentally, it also has the highest local average GL/DAL ratio. These two banks also share the highest average AGR among their local counterparts (except for the new bank SCB in Samoa). The common factor among this selected group of banks is the highest NIEX.

4.3 Secondary Data

Perhaps one of the most important items from the data in relation to the cost of intermediation is the individual bank's cost of deposits and the interest rate on loans. Unfortunately, this is not consistently disclosed and therefore the central banks' data on all commercial banks' weighted average rates on deposits on the basis of volume for all commercial banks (except in Fiji where the average Time deposit is used since the weighted average deposit is not available) and lending rates. Hence, a comparable platform is used to discuss the cost of deposits, interest charge on loans, and the interest rate margin, which is simply the interest on loans minus interest on deposits.

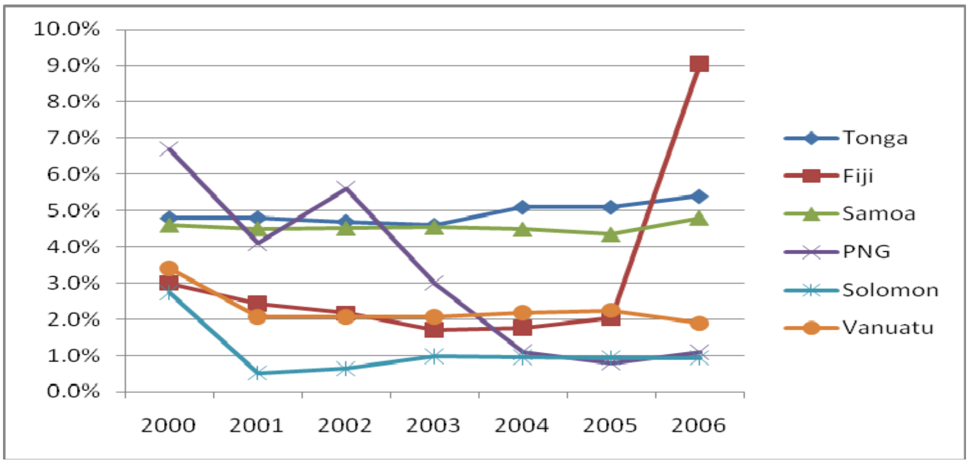
4.3.1 Regional Interest Margin

The regional average is the average for all six countries and it is consistently applied to the regional average for deposits, loans, and interest margin. These data also explain some of the trends in section 4.2.5.

Table 4.3: Regional Interest Margin: 2000-2006

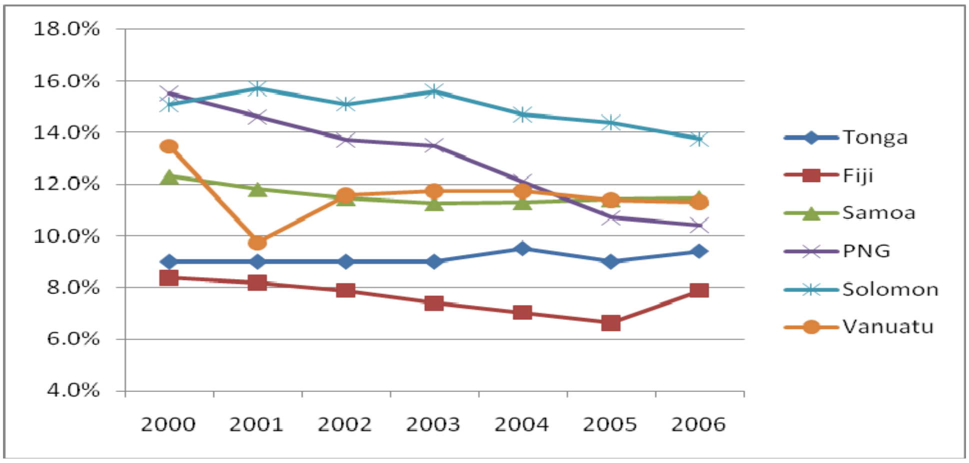
CBs Average rate	Deposits	Loans	Margin
Tonga	4.93%	9.13%	4.20%
Fiji	3.16%	7.63%	4.46%
Samoa	4.54%	11.57%	7.03%
PNG	3.20%	12.93%	9.73%
Solomon	1.10%	14.90%	13.80%
Vanuatu	2.28%	11.56%	9.28%
Regional Average	**3.20%**	**11.28%**	**8.08%**

Figure 7: Regional Average Deposit Rate: 2000 - 2006



The customers' deposits interest rate is consistently highest in Tonga followed by Samoa and PNG. Solomon is consistently enjoying the lowest access to customers' deposits followed by Vanuatu and Fiji. In addition, PNG is most notable in terms of the declining cost of accessing customers' deposits. Finally, the average deposit of 9.05% in 2006 for Fiji is unusually high compared to previous years but it coincides with the 2006 political coup, signalling the downside impact of political instability on the banking sector.

Figure 8: Regional Average Loan Rate: 2000 - 2006



The average lending rates are consistently highest for the Solomon Islands followed by PNG, Vanuatu, Samoa, Tonga, and Fiji charges the least on loans reflecting the RBF effort in compensating commercial banks' statutory deposits.

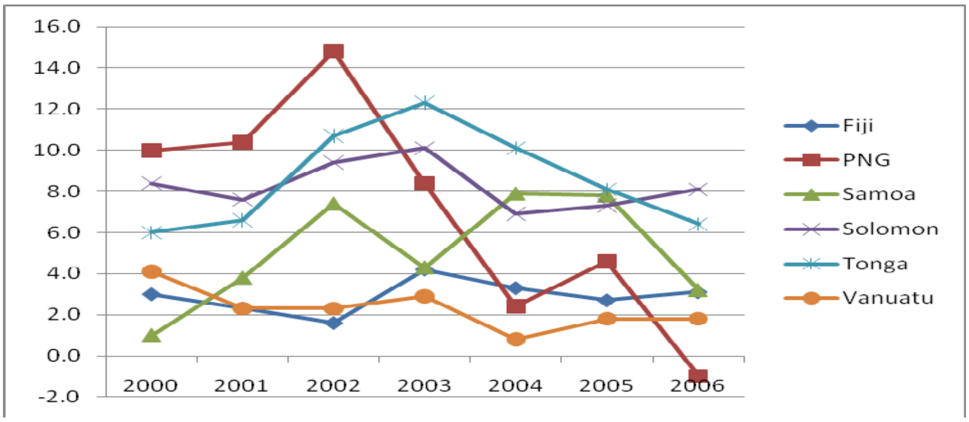
Finally, interest margin suggests that Solomon is consistently enjoying the highest followed by PNG and Vanuatu then Samoa. Fiji and Tonga share the lowest interest margin and it is totally unexpected to observe that Tonga is even behind Fiji. The local interest rates margin is relatively high in Solomon compared to regional standards and it is a reflection of high costs due to the small market size. This is further exemplified by the negative real interest rate on deposits, at -6.66% in 2006 and presents a particular problem for Solomon Islanders trying to save for the future.

One of the determinants of interest margin is attributed to the statutory reserve requirements. A report by the Central Bank of Solomon Islands (CBSI Focus Report, 2007) notes that when there is zero or low remuneration on reserves requirements, particularly in developing countries where inflation is higher, there is a high opportunity cost on these reserves and such costs are translated into a wider interest margin. On the other hand, when reserves are remunerated, interest margin tends to narrow.

4.3.2 Regional Inflation Rate

The justification for the inclusion of inflation rates is based on the notion that small economies are predominantly consumption based, as opposed to developed countries that are more production based. Furthermore, inflation is generally a focus for monetary policy and countering inflationary pressures does lead to local adjustments in monetary policy instruments; hence it could potentially impact bank efficiency.

Figure 9: Regional Inflation Rate: 2000 - 2006

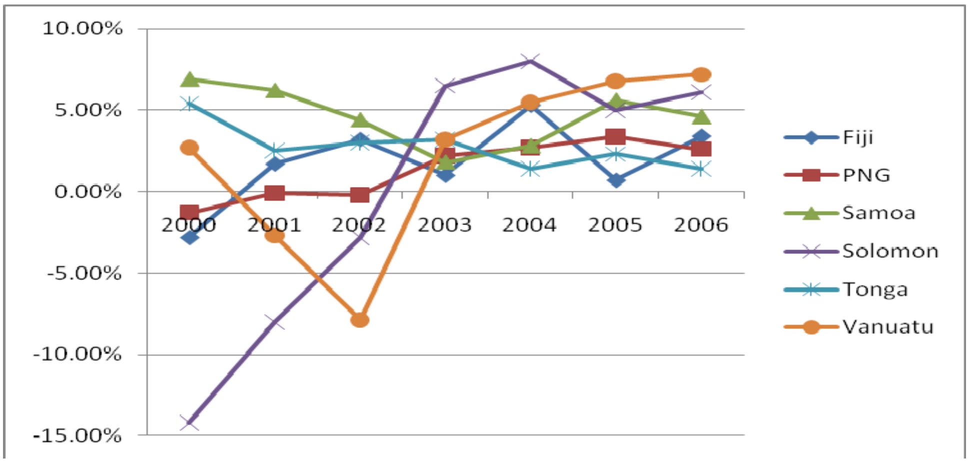


Inflation is more successfully contained in Vanuatu and Fiji where the average is less than 3%. On the other hand, Tonga, Solomon, and PNG struggle to contain inflationary pressure, although PNG is more successful from 2004 onwards with a negative rate in 2006. Inflation rate in Samoa appears to be quite erratic, however by 2006, inflation returns to a more respectable level at just over 3%.

4.3.3 Regional Gross Domestic Product (GDP)

The justification for the inclusion of GDP is fairly similar to that for the inclusion of the inflationary effect, through monetary policy. An additional justification for this is the notion that growth in commercial banks and the banking system does flow through to the wider economy. Hypothetically, there should be a connection between the two. Bear in mind that in these small economies, growth through equity financing and stock market is virtually non-existent.

Figure 10: Regional Real GDP: 2000 - 2006



The average real GDP growth is highest in Samoa and could well signal the resulting impact of the successful financial reforms, previously discussed in the previous chapter. It is followed by Tonga, Vanuatu, Fiji, and PNG. Solomon has the lowest average of less than 1%. This is caused by negative growth in the first three years. However, from 2003 onwards Solomon shows strong GDP growth. Solomon and Vanuatu reflect the largest volatility in real GDP.

4.4 Methodology

The methodology built upon the data discussion with three underlying objectives: banking efficiency measurement, a series of checkpoints to validate the resulting efficiency scores, and the explanations of banking efficiency variations. The first component utilizes the DEA approach in measuring banking efficiency, as explained and justified in chapter 2.

The second component of validating resulting efficiency scores goes beyond the current procedures in the literature. The literature commonly refers to the traditional profitability measures such as ROE and ROA, as the dominant checkpoints for validating efficiency scores. In this research project, in addition to the profitability measures, a productivity based measure is included.

The third component, the explanation of banking efficiency variations, is primarily focussing on the impact of several prudential requirements in addition to some other macro economic variables. The impact of prudential requirements on banking efficiency has not been addressed in the literature with any conviction (except some efforts have been dedicated to the impact of mergers and acquisitions and banking consolidations such as the summary of studies in Berger & Humphrey (1992) and Bauer et al (1998) and others incorporate a proxy for the degree of regulatory requirements such as Dietsch & Lozano-Vivas (2000), Carvallo & Kasman (2005), and Allen et al (2006)). This continues despite the common knowledge that the banking industry is the most regulated industry in the financial system. This component seeks to identify the potential determinants of bank efficiency differences and places little consideration in ceremonially awarding medals for highly efficient banks. However, efficiency results will be presented and accompanied by some suggestions for inefficient banks how to improve efficiency.

However, there is a concern regarding the use of explanatory variables to explain efficiency variation, as summarised by Grosskopf (1996). The three most important issues pointed out by Grosskopf including: efficiency scores are considered censored; why are explanatory variables not used in the original model, and if the explanatory variables are correlated with the original variables (inputs or output variables) then the second stage estimates are inconsistent and biased.

The first point can be countered by the first component of this methodology: the validation procedure. This process explains away, demystifies, and gives a sense of practical meaning to resulting efficiency. Otherwise, the censored status of the resulting efficiency scores continues to echo the myth of the legendary Hanging Garden of Babylon.

The second point is relatively easier to be explained. At least in the context of a small sample size, the decision to include or not include explanatory variables in the first place is due to the predetermined limitation surrounding the required number of inputs and outputs under DEA. Having too many input and output variables forces almost all DMUs to be fully efficient and the results are therefore meaningless.

The third question is more statistically challenging and perhaps the most difficult to address. However, Grosskopf has fortunately partially provided the best answer (p. 171) in citing Varian (1990), suggesting that what matters in economics (and banking to be precise) is whether violations of statistical procedures are statistically significant at the expense of violating economic significance. Bear in mind, the horse pulls the chariot and not vice versa.

These components dictate the structure of the remaining chapter: section 4.4.1 explains how the three banking models are used to develop the efficiency measurement; section 4.4.2 presents how bank efficiency is measured by DEA. Section 4.5 explains how the DEA models and the three banking models are combined to measure bank efficiency. This is followed by the evaluation of the differences in bank efficiency in section 4.6. Section 4.7 focuses on the validating procedures, then the operations of the two Australian based banks currently operating in all six countries; and the final section 4.9 presents a brief summary of the research questions.

4.4.1 Banking Models

As a consequence of the complexity of the banking industry, banking efficiency is proposed to be measured in three different levels under three separate models. Each model has its primary objectives and the subsequent model is built on the foundation of the previous but has an expanded series of research objectives. In the end, the final model captures the overall measure of banking efficiency. This proposal is consistent with an earlier suggestion by Cooper et al (2006).

The most immediate consideration in measuring banking efficiency under DEA is the choice of inputs and outputs but in the context of small economies with smaller number of banks, the number of inputs and outputs are equally or even more important. Barr et al (1999) and Dyson et al (2001) suggest the criteria for selecting the inputs and outputs for DEA to include: the factors cover the full range of resources used; the factors capture all activity levels and performance measures; and factors are common to all units. In addition, the literature suggests the number of observations should be greater than (3* sum of inputs and outputs variables).

The focus for Model 1 is the cost of intermediation, model 2 shifts the focus towards commercial banks traditional intermediation, and model 3 captures the overall production process by the commercial banks. These three models are explored on a national basis and regional basis. Both approaches are used in the literature separately but in this context each approach has a role to play in assisting the construct of banking efficiency and more importantly in explaining the potential causes for the variation in banking efficiency scores. This in turn provides greater potential for a more comprehensive series of validation procedures for efficiency scores derived from the local frontier in one hand and the regional or common frontier in the other. Therefore, resulting efficiency scores are expected to be more reliable and meaningful.

4.4.1.1 Model 1 - Cost of the Intermediation Process

The main objective for this model is to bridge the gap between efficiency and profitability since the only difference between the inputs and the outputs is the income statement resulting profits (except variation in tax obligations between countries and abnormal items are usually uniquely different from case to case). The input variables are interest expense (IEX) and non-interest expense (NIEX); and the output variables include interest income (IINC) and non-interest income (NIINC).

This simple model can also be used to track down how resulting efficiency scores change as the variables (inputs and outputs) in the other models are added. This aspect explains the isotone or more precisely, cd-directional isotone property of efficiency, previously discussed in chapter 2. In that context, variation in efficiency scores from this model is not analysed and in depth analysis is conducted on model 2 and 3.

4.4.1.2 Model 2 - Traditional Banking Activities

The focus of this model is to investigate the efficiency of the traditional banking activities based on the transformation of deposits into loans, and consequently, the intermediation process is the dominant feature of this model. This process also takes into consideration the impact of three primary data features earlier discussed: commercial banks annual growth, intermediation process, and asset quality.

Another consideration is to capture the potential impact of CAR on efficiency. The inclusion of the CAR in this discussion as opposed to model 3 is based on the notion that this prudential requirement is primarily expected to counter the possibility of over-lending by banking institutions and the likelihood of excessive credit risk.

The inputs variables are: total deposit (TD) and non-interest expense (NIEX); and the output variables consist of: gross loan (GL), net interest income (NTIC), and non-interest income (NIINC). The obvious difference between this model and the earlier model is evident in the expanded number of variables included: customer deposits is the dominant input, gross loans is the main output and interest based items are replaced by the net interest income variable as an output. In addition, the resulting efficiency scores from this model are further analysed to explain the potential determinants of banking efficiency variations. This analysis is conducted in both the national and the cross country frameworks. Finally, the resulting efficiency scores from both frameworks are validated to strengthen the reliability and economic contribution of the results.

4.4.1.3 Model 3 - Banking Production Process

This model is the most important component of the three models and it is expected to investigate some of the most challenging aspects of this research. The difference between this model and the earlier models are the expanded number of variables. The inputs variables are: deposit available for loans (DAL), defined as total deposits plus purchased funds minus SRD; non-interest expense (NIEX). The output variables consist of: gross loan (GL); non-interest income (NIINC); net-interest income (NTIC), it is the total interest income minus interest expense; and other earning assets (OEA) defined as net interbank position plus government debts and investment securities.

Similar to model 2, the resulting efficiency scores from this model are further analysed to explain the potential determinants of banking efficiency variations. Contrary to model 2, the impact of LAR, macro economic effects, and bank stability are the main considerations. Again, this analysis is conducted in both the national and the cross country frameworks. The resulting efficiency scores from both frameworks are also validated to strengthen the reliability of the resulting efficiency scores. However, the validation procedure for model 3 is more stringent than model 2 and this procedure is also repeated in both frameworks.

4.4.2 DEA Analysis

This notion of an adequate sample size necessary under DEA gives rise to the question of how DEA can be applied in small economies with very small number of banks. The common approach is to extend the number of years in which the smaller number of banks are analysed, hence panel data over seven years is incorporated (Tulkens & Vanden Eeckaut, 1995) and therefore, the issue of an adequate sample is satisfied.

4.4.2.1 DEA Models

The final decision to consider is which DEA model is most suitable for this data set. The CCR and BCC are the most common models to be used in bank efficiency. The main distinction between the two is that CCR assumes a constant return to scale where the BCC expands the CCR assumption to a variable return to scale where increasing, decreasing, and constant return to scale are incorporated. The additional dimensions offered by the BCC model are a concern when applying DEA to a small data set mainly due to the existence of self identifiers, as discussed in the literature. Therefore, CCR is the preferred choice but at the same time BCC will also be applied as it is necessary to obtain scale efficiency. Scale efficiency is measured as the ratio of CCR/BCC scores.

Finally, the existence of zero weighting in the CCR and BCC framework, as discussed in the literature chapter gives rise to the inclusion of the slack based measure (SBM) earlier proposed by Tone (2001). The SBM approach provides a supporting role for the CCR approach. In this context, the SBM-CRS non-oriented approach is preferred to the rest of the SBM based models.

4.4.2.2 The CCR and SBM Models (Cooper et al, 2006)

The CCR and SBM fractional program for the optimal solutions are presented in which bank efficiency is obtained. Hence, they illustrate the key distinctions between the two DEA approaches.

CCR Fractional Program and Optimal Solution

The (v*, u*) is the optimal solution for the linear program resulting in a set of optimal weights for the evaluated DMU $_j$. The evaluation is based on a ratio scale and represented by: $\theta^* = \dfrac{\sum_{r=1}^{s} u_r^* y_r}{\sum_{i=1}^{m} v_i^* x_i}$

If the denominator is 1 then $\theta^* = \sum_{r=1}^{s} u_r^* y_r$ and v_i* is the optimal weight for the input item i and its magnitude reflects how highly the item is evaluated. Similarly, u_r* is similar for the output item r. Thus, v_i* X_i in the input $\sum_{i=1}^{m} v_i^* y_i$ (=1) shows the relative importance of each item to the value of each v_i* X_i and similarly, for the output item.

CCR Efficiency and Inefficiency

A DMU$_j$ is CCR-efficient if θ^* =1 and there should be at least one optimal (v*, u*) where v* > 0 and u* > 0, otherwise DMU$_j$ is CCR-inefficient. Similarly, a DMU$_j$ is CCR-inefficient if θ^* <1 or θ^* = 1 and at least one element of (v*, u*) is zero for every optimal solution from the linear program.

SBM Fractional Program and Optimal solution

$$\text{Min}_{\lambda,\, s-,s+}\ \boldsymbol{\rho} = \frac{1-\frac{1}{m}\sum_{i=1}^{m} s_i^- / x_i}{1+\frac{1}{s}\sum_{r=1}^{s} s_r^+ / y_r}$$

Subject to $x_i = X\lambda_i + \mathbf{s}^-$, $y_r = Y\lambda_i - \mathbf{s}^+$, and $\lambda \geq 0$, $\mathbf{s}^- \geq 0$, $\mathbf{s}^+ \geq 0$

A notable assumption for the SBM model: if x = 0 then the last term in the numerator is deleted, and similarly if y=0, the last term on the denominator is replaced by a very small number and plays the role of penalty.

SBM Efficiency and Inefficiency

A DMU is SBM efficient if and only if ρ*=1, implying no input excess ($\mathbf{s}^{-*}$ = 0) or output shortfall ($\mathbf{s}^{+*}$ = 0) simultaneously. Inefficiency occurs when a DMU has input excess: $x_i = X\lambda_i^* + \mathbf{s}^{-*}$ or has output shortfall: $y_r = Y\lambda_i^* + \mathbf{s}^{+*}$

There are two types of SBM: the oriented SBM and non-oriented SBM. The latter considers both components (numerator and denominator) of the SBM. The former SBM varies whether it is an input oriented SBM, where the denominator of the fractional program is dropped; and the output oriented SBM, where the numerator is neglected and replaced by 1 with the remaining denominator.

4.5 Bank Efficiency Measurements.

The national frontier is applied in Fiji, PNG, and Samoa using all three banking models. The inclusion of these three countries is based on the quality of the data, as it is more comprehensive compared with the remaining three countries and the sample size is large enough to be meaningfully applied under DEA.

The most obvious feature of this data analysis is that commercial banks are compared against their local counterparts over the seven year period. Therefore, the impact of the local prudential requirements should assist in explaining the variation in banking efficiency since it is equally applied to all local commercial banks. Even, if a requirement changes over time then we expect the impact on all commercial banks to be consistent. Consequently, the homogeneous assumption across the dataset is warranted. Therefore, the variation in banking efficiency should be largely attributed to managements' decisions.

The descriptive statistics cover all three banking models. This is followed by the correlations among the inputs and outputs variables in models 2 and 3 only. The correlations are presented to reinforce the relationships between inputs and outputs variables.

4.5.1 The three National Frontiers: Fiji, PNG, and Samoa

The descriptive statistics for three national frontiers are presented in the local currency and rounded off to the nearest thousand dollars. The descriptive statistics for each national frontier is disclosed for all three banking models. The correlations among inputs and output variables are presented for models 2 and 3 since the dominant feature of data analysis is based on these two models.

Table 4.5A: Descriptive Statistics for the National Frontier in Fiji.

Model 1	IEX (I)	NIEX (I)	IINC (O)	NIINC (O)		
Max	14,604	57,097	77,257	56,334		
Min	134	1,152	1,286	810		
Average	4,673	19,792	25,121	15,275		
SD	3,732	17,139	19,287	15,150		
Model 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	
Max	1,210,730	57,097	1,064,020	56,334	62,653	
Min	19,655	1,152	5,332	810	964	
Average	403,100	19,792	298,678	15,275	20,448	
SD	316,514	17,139	269,817	15,150	16,079	
Model 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
Max	1,106,328	57,097	1,064,020	56,334	62,653	180,190
Min	16,172	1,152	5,332	810	964	3,080
Average	368,489	19,792	298,678	15,275	20,448	86,778
SD	285,425	17,139	269,817	15,150	16,079	55,003

Table 4.5B: Correlations among the Input and Output variables in Fiji

Model 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	
TD (I)	1					
NIEX (I)	0.9148	1				
GL (O)	0.9804	0.8876	1			
NIINC (O)	0.9597	0.9499	0.9315	1		
NTIC (O)	0.9828	0.8975	0.9822	0.9325	1	
Model 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
DAL (I)	1					
NIEX (I)	0.9041	1				
GL (O)	0.9824	0.8876	1			
NIINC (O)	0.9507	0.9499	0.9315	1		
NTIC (O)	0.9877	0.8975	0.9822	0.9325	1	
OEA (O)	0.5512	0.5152	0.3887	0.5285	0.4999	1

The correlations among inputs and output variables are fairly strong. The exception is between OEA and the rest in model 3, where the correlations are weak.

Table 4.5C: Descriptive Statistics for the National Frontier in PNG

Model 1	IEX (I)	NIEX (I)	IINC (O)	NIINC (O)		
Max	61,870	182,942	235,063	162,018		
Min	288	3,161	5,886	2,312		
Average	22,721	55,184	83,020	60,063		
SD	17,249	55,539	62,116	49,939		
Model 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	
Max	3,776,380	182,942	1,196,425	162,018	209,423	
Min	43,036	3,161	14,844	2,312	5,465	
Average	837,936	55,184	366,324	60,063	60,300	
SD	836,716	55,539	297,466	49,939	52,416	
Model 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
Max	3,666,772	182,942	1,196,425	162,018	209,423	2,528,616
Min	40,841	3,161	14,844	2,312	5,465	47,097
Average	807,608	55,184	366,324	60,063	60,300	480,007
SD	812,455	55,539	297,466	49,939	52,416	545,586

Table 4.5D: Correlations among the Input and Output variables in PNG

Model 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	
TD (I)	1					
NIEX (I)	0.8972	1				
GL (O)	0.9666	0.9216	1			
NIINC (O)	0.7811	0.7218	0.8289	1		
NTIC (O)	0.9508	0.9724	0.9512	0.7457	1	
Model 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
DAL (I)	1					
NIEX (I)	0.8964	1				
GL (O)	0.9653	0.9216	1			
NIINC (O)	0.7820	0.7218	0.8289	1		
NTIC (O)	0.9501	0.9724	0.9512	0.7457	1	
OEA (O)	0.9847	0.8381	0.9140	0.7509	0.9130	1

The correlations among inputs and output variables are fairly strong. The exception is between NIINC and the rest in both models, where the strength of the correlations is marginally reduced but still strong. The OEA correlation is much stronger against all variables in model 3, a contrast to Fiji, reflecting the high liquidity requirements in PNG at 25% compared to no formal liquidity requirements in Fiji.

Table 4.5E: Descriptive Statistics for the National Frontier: Samoa

Model 1	IEX (I)	NIEX (I)	IINC (O)	NIINC (O)		
Max	8,846	20,399	30,827	21,908		
Min	300	1,244	597	381		
Average	4,224	8,054	11,721	7,751		
SD	2,685	5,927	9,002	7,103		
Model 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	
Max	267,912	20,399	301,472	21,908	22,414	
Min	16,928	1,244	12,166	381	297	
Average	115,931	8,054	100,358	7,751	7,496	
SD	86,609	5,927	77,035	7,103	6,432	
Model 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
Max	256,843	20,399	301,472	21,908	22,414	116,811
Min	13,586	1,244	12,166	381	297	1,025
Average	109,305	8,054	100,358	7,751	7,496	24,801
SD	85,254	5,927	77,035	7,103	6,432	31,980

Table 4.5F: Correlations among the Input and Output variables in Samoa

Model 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	
TD (I)	1					
NIEX (I)	0.9449	1				
GL (O)	0.9644	0.9335	1			
NIINC (O)	0.9652	0.9848	0.9476	1		
NTIC (O)	0.9796	0.9606	0.9761	0.9726	1	
Model 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
DAL (I)	1					
NIEX (I)	0.9397	1				
GL (O)	0.9632	0.9335	1			
NIINC (O)	0.9620	0.9848	0.9476	1		
NTIC (O)	0.9764	0.9606	0.9761	0.9726	1	
OEA (O)	0.8551	0.7611	0.6951	0.7935	0.7897	1

The correlations among inputs and output variables are fairly strong. The exception is between OEA and the rest in model 3, where the strength of the correlations is weakening, although it is significantly higher than Fiji (despite both countries having no formal LAR and Samoa has less SRD than Fiji) but less than PNG.

4.5.2 Common Frontier for all Commercial Banks

The data are transformed using the annual average USD exchange rate against the local currency and rounding off to the nearest thousands. The implication of this procedure is based on the assumption that commercial banks are operating under a common frontier. In one hand, this procedure is necessary to investigate the resulting impact of the variation in prudential requirements from one country to the rest. In that context, resulting efficiency scores are influenced by bank management decisions, variation in prudential requirements across countries, and variation in economic conditions.

The main concern for this procedure is the compromised impact of the homogeneity assumption. Under the national frontier framework, this assumption is ensured, and not so in this context. However, this approach is still a necessary step to pursue and it is commonly practised in the literature. This frontier offers the largest sample size, and the resulting efficiency scores will be less influenced by the small sample effects compared to the national frontiers. Finally, the correlations among input and output variables are disclosed for each banking model.

Table 4.5G: Descriptive Statistics for the Common Frontier: Model 1

USD (000)	IEX (I)	NIEX (I)	IINC (O)	NIINC (O)
Max	18,777	57,552	76,901	53,004
Min	79	318	201	18
Average	2,625	7,571	10,410	7,367
SD	3,642	10,951	13,878	10,702
Correlations	IEX (I)	NIEX (I)	IINC (O)	NIINC (O)
IEX (I)	1			
NIEX (I)	0.6200	1		
IINC (O)	0.7999	0.9399	1	
NIINC (O)	0.5426	0.8442	0.8339	1

Table 4.5H: Descriptive Statistics for the Common Frontier: Model 2

USD (000)	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)
Max	1,235,443	57,552	614,579	53,004	68,513
Min	3,362	318	2,513	18	100
Average	129,140	7,571	79,338	7,367	7,874
SD	185,927	10,951	109,484	10,702	11,130
Correlations	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)
TD (I)	1				
NIEX (I)	0.9248	1			
GL (O)	0.8933	0.7888	1		
NIINC (O)	0.8511	0.8442	0.7190	1	
NTIC (O)	0.9605	0.9652	0.8178	0.8593	1

Table 4.5I: Descriptive Statistics for the Common Frontier: Model 3

USD (000)	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
Max	1,199,585	57,552	614,579	53,004	68,513	827,237
Min	2,854	318	2,513	18	100	198
Average	121,007	7,571	79,338	7,367	7,874	47,553
SD	176,116	10,951	109,484	10,702	11,130	99,905
Correlations	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
DAL (I)	1					
NIEX (I)	0.9263	1				
GL (O)	0.8779	0.7888	1			
NIINC (O)	0.8554	0.8442	0.7190	1		
NTIC (O)	0.9657	0.9652	0.8178	0.8593	1	
OEA (O)	0.8576	0.8159	0.5109	0.7829	0.8621	1

4.6 Evaluating the Differences in Bank Efficiency

This section's primary objective is to explain the variation in commercial banks' efficiency scores. It follows some of the guidelines earlier proposed by Berger & Mester (1997): the correlations of these explanatory variables with efficiency. As mentioned earlier, different banking models have different roles to contribute. In this section the focus is on model 2 and 3.

4.6.1 Technical Efficiency, Scale Efficiency, and CAR

Q1: Is CAR relevant to explaining variation in technical and scale efficiency?

Q1 assumes that higher level of bank's annual CAR beyond the CAR framework reflects more room for intermediation and consequently the expected relationship ought to be negatively related with scale efficiency[9]. In other words, high CAR signals deficient intermediation and lower productivity and possibly less efficiency. However, the relationship between technical efficiency and CAR is uncertain but most likely to be negatively correlated with similar justification as for scale efficiency. Therefore, this question also incorporates Q3 and Q4 in a slightly different manner from Q5 as it is bypassing asset quality while questioning the volume of intermediation.

[9] It would have been good to include the amount of capital as an input in the production process, but this was made problematic by the sample size.

Since, the CAR data for individual banks is only available in Fiji and PNG, the number of DMUs is reduced to 63 in the common frontier. The resulting trend from the two national frontiers is also compared to the common frontier to confirm the consistency of the correlation between CAR, technical, and scale efficiency across banking models 2 and 3. Finally, the correlation is expected to be weaker for the latter model since the former focuses on bank intermediation previously explained in section 4.4.1.

4.6.2 Efficiency through Time

The second research question to address is how efficiency changes through time. This notion is important whether commercial banks do learn and improve efficiency over time.

Q2: Does efficiency improve through time?

The multi dimension offered by the three national frontiers in addition to the common frontier provides more opportunities to address this question. The three national frontiers will provide the average efficiency scores for each country from 2000 to 2006 and the Common frontier presents the overall efficiency scores for all commercial banks in the region for the same period.

4.6.3 Efficiency and Annual Growth

Q3: Could efficiency be explained by annual growth?

Q3 considers both annual growth in loans and assets (definitions and regional discussions in sections 4.2.2) and their correlation with the efficiency scores. Hypothetically, both loans and assets should highly positively correlate with efficiency based on the notion that high growth should be translated into higher efficiency and vice versa. It is also worth noting here that the loan portfolio generally accounts for most of the banking assets but in some cases it is not. However, this perception is also subject to the effectiveness in managing the loan portfolio under various economic conditions.

In the context of the common frontier, it is investigated from two perspectives: the individual DMUs and the banks' average. The former has 131 observations (accounting for 131 DMUs from the dataset), while the latter has 20 observations, representing the available data for the 20 commercial banks from the six countries. The results from the two approaches should be fairly similar but the latter approach is expected to dilute the impacts of extreme observations or outliers.

4.6.4 Efficiency and Intermediation

Q4: Does efficiency correlate with the degree of intermediation?

Q4 follows the same logic as Q3 except degree of intermediation is used and proxied by the GL/DAL ratio, as explained in section 4.2.3. Hypothetically, it should be positively correlated with efficiency based on the notion that high intermediation should be translated into higher efficiency and vice versa. Again, the effectiveness in managing the loan portfolio under various economic conditions remains a consideration.

4.6.5 Efficiency and Asset Quality

Q5: Does efficiency reflect bank asset quality?

Asset quality is measured by the PDD/GL and BDD/PDD ratios (definitions and regional discussions in sections 4.2.4). As explained before the distinction between the two ratios is that the former measures the adequacy of loan provisions for future losses while the latter addresses the current losses. Hypothetically, both ratios should correlate negatively with efficiency based on the notion that higher loan provisions and loan losses lead to reduced intermediation and possibly lower productivity and lower efficiency and vice versa. This question reflects the effectiveness in managing the loan portfolio under various economic conditions. Therefore, this question binds together managements' efforts in Q3 and Q4.

4.6.6 Efficiency and Liquidity

Q6: What is the impact of liquidity requirements on efficiency?

This question addresses the impact of liquidity requirements on efficiency, previously tabled by Saunders (1993). This is a challenging task to consider but hypothetically, higher liquid assets in countries with higher liquidity requirements should be translated into lower efficiency based on the notion that holding liquid assets leads to forgoing valuable resources that could be better utilised through loans. On the other hand, holding liquid assets is a necessary tool to counter liquidity risk. Therefore the dependent variable is bank efficiency and the independent variable is the percentage of liquid assets to total assets.

In this case, the expectation is complicated by the fact that SRD is deducted from deposits and non-cash liquid assets are included in the other-earning assets variable. Therefore, the expected relationship is most likely to result from the balancing effect of the reduced input variable DAL and the OEA output variable. Bear in mind that OEA is the net effect of the commercial banks' net interbank position plus investments including local government debts securities that are held by the commercial banks under liquidity requirements. Thus, the expectation is uncertainty.

Liquidity is expected to be better explained by the common frontier compared to the national frontiers. Local prudential framework equally is applied to all banks and the variation between countries is expected to be captured. Liquidity is measured in two ways: liquid asset ratio 1 (LAR 1) and liquid asset ratio 2 (LAR 2). The former is defined as the individual bank's holding of liquid assets including notes and coins and SRD balance with the central bank. The latter incorporates other liquid asset sources banks rely on when liquidity needs arise, therefore the definition is widened to include LAR 1 plus, net inter bank position (balances due from other banks minus balance due to other banks) and other securities and investments that banks required to hold in conjunction with the liquid asset requirements, and these are mainly made up of local government debt instruments. Both LAR 1 and LAR 2 are measured as a ratio over total assets.

Table 4.6A: Commercial Banks' Average Liquid Assets

Fiji	ANZ	WPC	CNB	BOB	HBB	Average
LAR 1	11.94%	6.44%	10.43%	8.17%	15.50%	10.50%
LAR 2	29.34%	20.90%	29.12%	60.35%	46.72%	37.29%
PNG	BSP	ANZ	WPC	MBK		
LAR 1	6.76%	9.74%	11.64%	10.29%		9.61%
LAR 2	54.01%	53.83%	49.55%	75.60%		58.25%
Samoa	ANZ	WPC	NBS	SCB		
LAR 1	5.54%	6.57%	20.75%	15.78%		12.16%
LAR 2	28.10%	18.47%	25.78%	25.37%		24.43%
Solomon	NBSI	ANZ	WPC			
LAR 1	22.65%	33.67%	17.75%			24.69%
LAR 2	62.86%	51.59%	42.28%			52.24%
Tonga	WPC	ANZ	MBF			
LAR 1	13.27%	12.95%	32.38%			19.53%
LAR 2	24.86%	19.82%	46.10%			30.26%

While LAR 1 is the most common feature of LAR in normal economic conditions and perhaps considered as the first line of defence against liquidity risk, LAR 2 on the other hand is a more comprehensive measure of the local prudential requirements and local banks' experience. The expectation is that LAR 2 should be stronger correlated with efficiency than LAR 1. The coefficient of both measures should be negatively related with bank efficiency.

4.6.7 Efficiency and Asset Size

The next three questions consider the resulting efficiency scores' correlation with several bank specific characters, as argued by Berger & Mester (1997). The proposed characters to consider including bank size, foreign ownership, equity.

Q7: Does asset size matter in efficiency?

Q7 defines large banks as the two Australian based banks (WPC and ANZ) and BSP and the rest are considered as small banks. These three banks account for over 80% of banking assets in the region. Their efficiency and overall well being is critical to the stability of these banking systems.

The average efficiency score for BSP in PNG, ANZ and WPC across the five countries are compared against the average efficiency score for the rest of the banks. The expectation is that large banks' dominance should be translated into more intermediation and higher efficiency compared to their smaller counterparts.

4.6.8 Efficiency and Foreign Banks

Q8: Do foreign owned banks bring along better technical know-how and consequently improving bank efficiency?

Q8 defines foreign-owned as the two Australian banks only. Other banks that are not locally owned such as MBF in Tonga, CNB, BOB, HBB in Fiji, and MBK in PNG are small foreign-owned banks but if they are treated as foreign owned here then only a few banks remain and the comparison is meaningless. Also, the two Australian banks' operations in all six countries are adequate to capture the potential impact of foreign ownerships in this context and they account for over 60% of banking assets in the region. However, the unavailability of banking data for both banks in Vanuatu gives rise to the comparison based only on the five remaining countries.

The average efficiency score for both ANZ and WPC across the five countries are compared against the average efficiency score for the rest of the banks. The expectation is that foreign banks technical know how and experience should be translated into more intermediation and higher efficiency compared to their local counterparts. Havrylchyk (2006) argues that foreign banks in developing countries achieve this by exploiting their comparative advantages and showing higher efficiency than their domestically owned counterparts.

4.6.9 Efficiency and Equity

Q9: Does equity promote efficiency?

Equity is measured by the ratio of annual equity over total assets. It is not included in the DEA input and output variables but it is used here to explain whether commercial banks' holding of equity can explain the variation in banking efficiency. Therefore, the correlation of equity against the resulting efficiency scores from models 2 and 3 is the focus.

Table 4.6B: Commercial Banks' Average Equity

Fiji	ANZ	WPC	CNB	BOB	HBB	Average
EQ/TA	7.20%	8.05%	7.02%	6.85%	11.80%	8.18%
PNG	BSP	ANZ	WPC	MBK		
EQ/TA	10.03%	12.47%	10.18%	31.57%		16.06%
Samoa	ANZ	WPC	NBS	SCB		
EQ/TA	19.12%	12.73%	11.45%	10.36%		13.42%
Solomon	NBSI	ANZ	WPC			
EQ/TA	21.26%	12.29%	11.82%			13.15%
Tonga	WPC	ANZ	MBF			
EQ/TA	14.71%	13.62%	18.17%			15.42%

The expectation is that equity should correlate better with the resulting efficiency scores from model 2 compared to model 3 based on the notion that the CAR requirements is most likely to play a stronger role in the first model than the last. Bear in mind, the former accounts for the intermediation process and the latter model focuses on the overall production of the commercial banks where intermediation and other earning assets are combined.

4.6.10 Efficiency and Macro Economic Variables

The impact of macro-economic factors in bank efficiency is an important consideration for cross country comparisons. The justification is based on the notion that variation in banking efficiency across countries is influenced by other factors that are outside the control of bank managers, previously discussed in section 2.7.

In this context, the efficiency results from the common frontier are regressed against the local average annual inflation rate, annual GDP per capita, and the annual banking assets per capita. The first component is necessary to explain the inflationary effect in bank efficiency. The second component addresses the wider macro-economic effect, and the final component is a proxy for banking development.

Q10: Could efficiency be explained by Inflation, GDP, and banking development?

The regression equation is: $BE_{DEA} = \beta_1$ INF + β_2 GDP + β_3 ABS. The dependent variable, BE_{DEA} is the resulting bank efficiency scores from the common frontier; INF is the annual inflation; GDP is the annual GDP per capita; ABS is the annual total of all commercial banks asset per capita in order to proxy the accessibility to banking services; β_1, β_2, β_3 are the coefficients of the three variables. [10]

The resulting variation presented by these three macro-economic variables in banking efficiency is the primary focus. In that, they should be presented in a manner that is comparable to the expected range of resulting efficiency scores from DEA. Therefore, all three variables are addressed and presented individually. INF is the inflation variable and ranges from -1.0 in 2006 to 14.8 and both occur in PNG. In that, the log (INF) is the necessary transformation. The GDP variable is the market rate of nominal GDP per capita and converted by the local annual average USD exchange rate to mitigate the variation in currency. The range for this variable is lowest in the Solomon at 486 in 2003 and highest in Fiji at 3500 in 2006. Again, the log (GDP) transformation is the necessary transformation. Similarly, the ABS variable accounts for the overall commercial bank assets per capita and is converted by the USD with the same logic as the GDP. The range for this variable is the largest in all three macroeconomic variables, lowest at 145 in Solomon in 2002 and highest in Vanuatu at 2436 in 2006. Again, the log (ABS) transformation is necessary. Hence the regression equation is: $BE_{DEA} = \beta_1 \log(INF) + \beta_2 \log(GDP) + \beta_3 \log(ABS)$.

Table 4.6C: Regional Average Macro-Economic Variables: 2000-2006

	log (INF)	log (GDP)	log (ABS)
Fiji	0.44	3.42	3.14
PNG	0.73	2.83	2.30
Samoa	0.63	3.24	2.97
Solomon	0.91	2.77	2.32
Tonga	0.92	3.15	3.04
Vanuatu	0.27	2.82	3.29

The annualised macroeconomic variables are presented against the annual efficiency scores for each bank in each country. For instance, the three variables are identical for

[10] An OLS regression cannot in fact be relied on in this context, but the extent of error is not large, and the approximation from using OLS will suffice for the argument.

all five banks in Fiji for any given year and so forth. Consequently, the variation in efficiency is assumed to be subjected only to the variations from the macro-economic variables from one year to the next. This procedure is repeated twice. The first regression, $BE_{\mathbf{DEA}}$ is the CCR model 3 efficiency scores from the Common frontier; the second regression replaces the CCR by the SBM model 3 efficiency scores.

This question is based on the notion that these small economies are more consumption based economies and therefore inflation could well be dominated by local consumption through the inflationary effect of imports (Nindim, 2006 and Sampson et al, 2006). Similarly, GDP is expected to signal economic productivity whereas banking development signals the accessibility to banking services (ABS). Therefore, efficiency ought to be better correlated with ABS, followed by GDP than INF.

This perceived order of influence could be argued by the existence of contagion effects in banking, hence β_3 is expected to be greater than β_1 and β_2, followed by β_2 since the stability of the banking system is the primary role of banking supervision, therefore, banks are more likely to be protected from adverse economic conditions. Finally, β_1 is expected to have the least effect on bank efficiency as these economies are primarily consumption based.

The main concern regarding this procedure is the obvious assumption that these macro-economic variables' effect on bank efficiency is linearly related and independent, which is likely to be unrealistic. Furthermore, resulting efficiency scores are used as the dependent variable. Bear in mind that efficiency scores are determined by the inputs and output variables, previously explained in sections 4.4 and 4.5.

4.7 Bank Efficiency Validating Procedures

This procedure is one of the primary objectives of this research project. In that, resulting efficiency scores should be validated from a wider series of checkpoints to strengthen the reliability and practical meaning of the resulting efficiency scores. This approach is an extension of the "possible tie-breaker conditions" earlier promoted by Bauer et al (1998). However, this validation process requires greater scope and consequently, all three banking models are utilised in each subsection.

The five main procedures in this validation process are: isotone property of efficiency; consistent ranking of efficiency across the banking models by the two DEA models; comparing the stability of the cost to income ratio to the resulting efficiency scores from the three models; the correlation between efficiency and profitability measures; and a new productivity based ratio: the Tripal Ratio[11] (TR) is correlated against resulting efficiency scores. This ratio is defined as the unweighted total output over unweighted total input.

The rationale for this ratio is based on the notion that DEA is a deterministic model and the resulting efficiency scores is a measure of productivity. Consequently, the most effective validating measure of efficiency scores under DEA should be productivity based and more importantly must be internally sourced from the very data that is currently used to obtain efficiency. In addition, the deterministic nature of the data under DEA should be assessed by an equally deterministic productivity based measure. In this context, the three banking models must be validated by three Tripal Ratios: TR1, TR2, and TR3 respectively.

The application of the Tripal Ratio is a variation of an earlier approach by Zhu (1998), Chen & Ali (2002) and Büschken (2009). Zhu's approach is based on the principal component analysis by applying a homogenous weighting procedure to all DMUs. Chen & Ali's approach is based on an all output-input ratio analysis. Buschken combines the two approaches but simplifies the weighting procedure by averaging all ratios out to generate a scalar efficiency score. However, this Tripal ratio approach further simplifies these three approaches by focussing only on the overall output-input ratio for each DMU. This simplification is a necessary step considering the main distinction between the two DEA approaches (the CCR and SBM) is the latter's attempt to account for input and output slacks for each DMU.

An additional justification for the incorporation of this Tripal ratio is that it is consistent with the traditional profitability procedure, which is merely the difference in operating revenue against operating expense. Finally, resulting trends obtained

[11] Tripal Ratio is named after my primary supervisor (David Tripe) for his effort in ensuring that all data and results ought to be checked, rechecked, and clearly marked "CHECKED" throughout.

through the DEA analysis (such as efficiency distribution) is discussed alongside the existing trend from the raw data. In that context, this ratio explains what is lost or gained through translation (raw data to resulting efficiency scores through DEA).

Perhaps, an obvious missing component of this validation process is bootstrapping. Boostrapping is a resampling technique commonly used to explore the empirical estimation of the underlying sampling distribution of DEA efficient estimates (Berger & Humphrey, 1997). It is a computer-based method for assigning measures of accuracy to statistical estimates, introduced by Efron (1979) and Simar (1992) for computing confidence intervals for efficiency scores derived from non-parametric frontier methods (Casu & Molyneux, 2003).

However, in the context of small economies with smaller number of banks, this procedure is not only exhausting but impractical due to the problem of resampling an already small sample. Berger & Humphrey (1997) consider bootstrapping as a non-statistically non-trivial matter (p. 179).

4.7.1 Isotone Property across the three Banking Models

The first question to explore is to investigate how banking efficiency changes across the three banking models. This is the isotone property of efficiency. The general expectation is that efficiency should be higher in model 2 compared to model 1 and model 3 should be even higher compared to the other two. This question is attributed to Farrell (1957), suggesting that a property of efficiency is that increasing the variables (mainly inputs) should increase the level of efficiency due to the increasing variation explained by the model. This isotone property of efficiency is not commonly investigated in banking, even in DEA as the common practise is the employment of a single production frontier model.

Q11: $Model\ 1_{Eff} \leq Model\ 2_{Eff} \leq Model\ 3_{Eff}$

Further justification for this question is based on the nature of banking where the loan portfolio and the intermediation process is realised over a much longer time frame, reflecting the dominant risk in banking of credit risk. Furthermore, profitability measures are normally focussing only on the annual realised component of banking production and therefore, presenting the challenges for banking institutions for ongoing management and monitoring asset quality.

4.7.2 Consistent ranking of bank efficiency across three banking models

This investigation is based on the consistency of ranking of individual banks by the CCR and SBM across the three banking models. The logical expectation is that average bank efficiency distribution should be consistent across the three models. In other words, the average efficiency score for dominant banks in model 1 should remain dominant in the other two models and vice versa.

Q12: Is efficiency consistently measured between the three banking models?

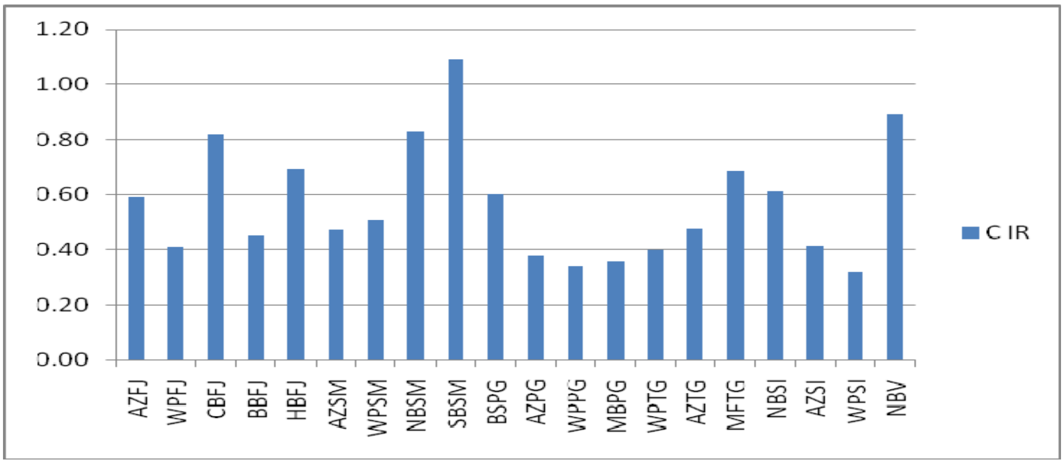
A potential drawback with this approach is that additional variables are added simultaneously to both inputs and outputs. This is further complicated by the fact that the interest based items in model 1 are adjusted in model 2 and model 3 as the net interest income (output) as opposed to being separately used as an input (interest expense) and output (interest income) in model 1.

This analysis also compares the ranking in banking efficiency from the three national frontiers to their respecting rankings from the CCC frontier. As such, only the commercial banks in Fiji, Samoa, and PNG are used for this comparison. Furthermore, if DEA is a reliable measure of efficiency then the commercial banks' efficiency scores obtained from the national frontier should be consistent with the resulting scores obtained from the common frontier. The most efficient banks from the local frontier should remain most efficient compared to their local counterparts with their resulting efficiency scores from the CCC frontier.

4.7.3 Cost to Income Ratio (CIR) and bank efficiency

The following histogram depicts the comparable average CIR across the commercial banks. The first five banks (AZFJ to HBFJ) represent the five commercial banks in Fiji: ANZ, WPC, CNB, BOB, and HBB. The following four are the commercial banks in Samoa (ANZ, WPC, NBS, and SCB) then the four banks in PNG (BSP, ANZ, WPC, and HBB). The next three banks are from Tonga (WPC, ANZ, and MBK), then the next three banks from the Solomons (NBSI, ANZ, and WPC), and the last bank is the National Bank of Vanuatu.

Figure 11: Commercial Banks' Average CIR (%): 2000 - 2006



The regional average is 60.00%, which is the average of all six countries.

CIR is defined as the ratio of non-interest expense to net-operating income (net interest income plus non-interest income). The denominator net interest income depends on the interest differential between assets (loans) and liabilities (deposits). This simple ratio is commonly disclosed in the region within the financial statements as an efficiency ratio but in most cases, it is basically a ratio of operating expenses to operating income.

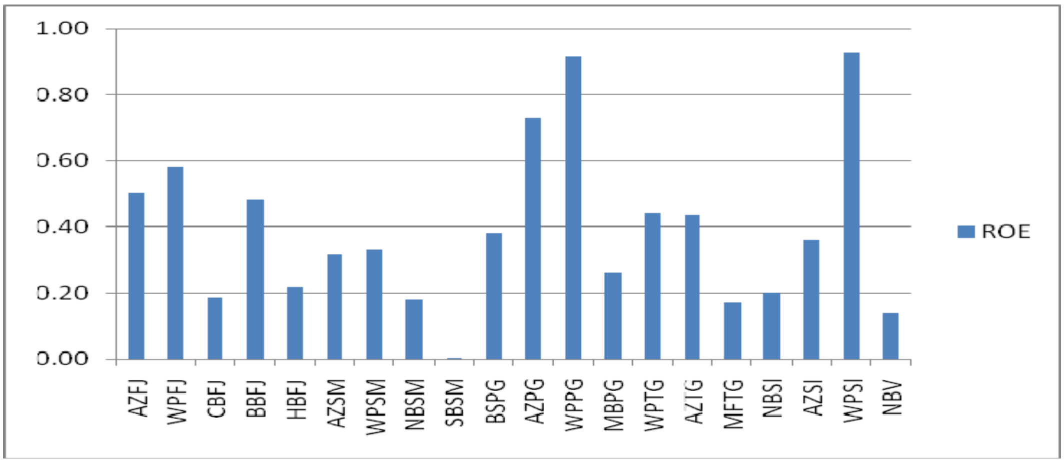
Q13: Could CIR explain bank efficiency?

The general expectation is that the CIR is most likely to correlate best with the model 1 model by definition. However, correlation with efficiency scores from model 2 and model 3 are also important to quantify the efficacy of this simple ratio in estimating banking efficiency from multi inputs and outputs dimensions.

4.7.4 Profitability and efficiency

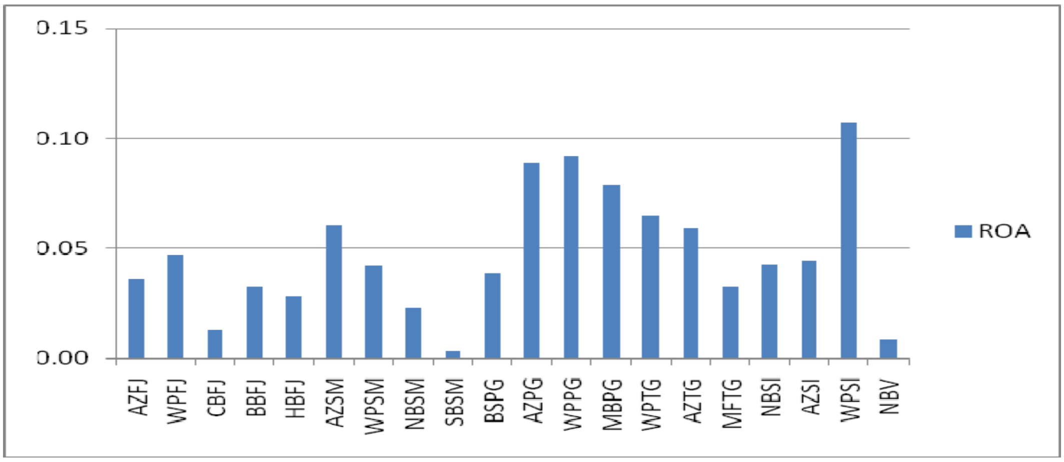
This profit performance measure is measured by return on equity (ROE) and return on asset (ROA). The former is defined as operating profit before tax and abnormal items over total equity, the latter replaces equity with assets. This definition offers a more comparable measure across countries where tax obligations do vary. The regional average for ROE is 36.03% and 4.39% for ROA.

Figure 12: Commercial Bank's Average ROE (%): 2000 - 2006



The commercial banks are presented in the same order as in Fig. 11

Figure 13: Commercial Bank's Average ROA (%): 2000 - 2006



The commercial banks are presented in the same order as in Fig. 11

Q14: Does efficiency correlate with ROE?

Q15: Does efficiency correlate stronger with ROA compared to ROE?

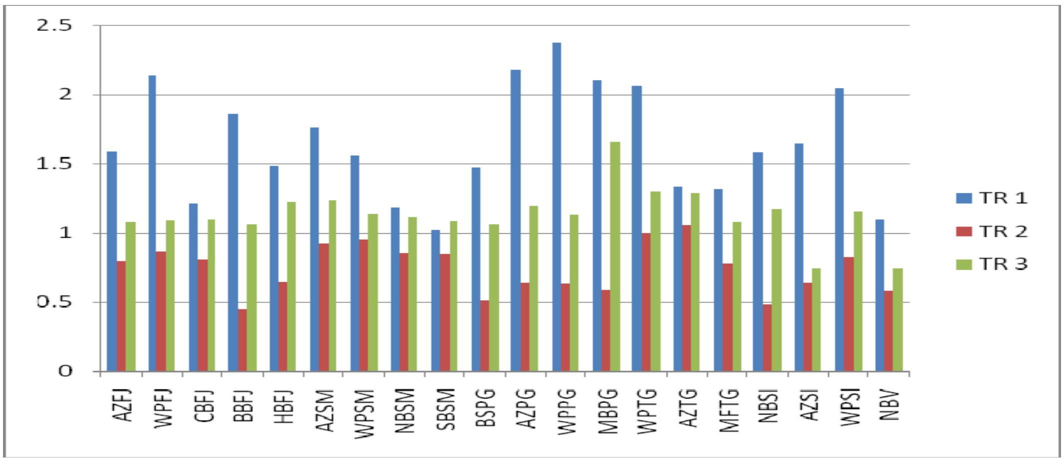
In this case, resulting efficiency scores are correlated against return on equity and return on assets. The correlation between ROE and efficiency from both CCR and SBM across three banking models is analysed for each of the three national frontiers. The expectation is that efficiency should correlate positively with both ROE and ROA and ROA should be higher than ROE based on the notion that efficiency is a productivity based measure and should feature closer to ROA.

For the common frontier perspective, these questions are compared under the DMUs comparison, which has 131 observations and the average bank level with 20 observations. The results from both analyses should be consistent but the latter is expected to mitigate the impact of self-identified 100% efficient DMUs or outliers.

4.7.5 Tripal Ratio and efficiency

This ratio is already introduced in section 4.7. The Tripal ratio for model 1 is consequently a direct comparison of the interest and non interest items, resulting in a ratio reflection of profitability. In model 2, it focuses on the intermediation process and expanded in model 3 to capture the overall production of all commercial banks. Figure 14 summarises the trend for all three banking models for each commercial bank in the region and Table 4.7.5 presents the regional average.

Figure 14: Commercial Banks' Average Tripal Ratios across Banking Models



The commercial banks are presented in the same order as in Fig. 11

An obvious trend emerging from these graphs is the dominance of the Tripal Ratio from model 1 (gross profit) over the other models. Model 2 (intermediation) is the lowest, and model 3 (bank production) is less varied compared to models 1 and 2. The last observation, confirms the structural construct of the three banking models and implying that model 3 should best reflect the overall production of the commercial banks.

Table 4.7: Regional Average Tripal Ratio across the Banking Models

	Fiji	PNG	Samoa	Solomon	Tonga	Vanuatu
TR1	1.66	2.03	1.38	1.76	1.57	1.1
TR2	0.71	0.59	0.9	0.65	0.95	0.59
TR3	1.11	1.26	1.14	1.02	1.22	0.74

Q16: Could efficiency be explained by the Tripal Ratio?

The focus here is to compare the Tripal Ratio against resulting efficiency scores from each respective banking model. The logical expectation is that TR1 and model 1 should correlate best, followed by TR2 and model 2, and TR3 and model 3 should correlate the least due to the complexity of the corresponding models. The resulting efficiency scores from both CCR and SBM are also compared against the TR ratios. The observed trend from this analysis provides a comparable platform for the effectiveness of the Tripal ratios in the cross-country comparison.

Under the common frontier perspective, this procedure is equivalent to the three previous research questions where both DMUs and banks average are analysed. An additional feature of this analysis is the comparisons of the Tripal ratios across the six countries. In that TR1, TR2, and TR3 is analysed across the six countries and observe whether the average ratios for each country could potentially contribute to the resulting efficiency scores for the commercial banks in each jurisdiction.

4.8 Efficiency scores of the two Australian Banks

The resulting efficiency score for each island nation is then compared to the efficiency scores of both Australian banks for that particular locality.

Q17: Is efficiency consistent between national and common frontier?

Q18: Does efficiency consistently rank banks between national and common frontier?

Hypothetically, there should be a pattern to emerge, preferably, a significant correlation between the variations on efficiency scores for the two banks and that of the PIC they operate in. In other words, if the efficiency scores for the ANZ and Westpac in Samoa are higher than that found in Tonga; we would expect the resulting efficiency for the Samoan banking system to dominate the result for the Tongan banking system. An additional contribution of this section is that it can also be used as a validation tool to assess the consistency of resulting efficiency scores from the national frontier and the common frontier.

4.9 Chapter Summary

Table 4.9: Summary of the Main Research Questions

Research Questions	Variable (s)	Variable (s)	Expectations
Q1: Technical & Scale & CAR	Technical & Scale	CAR	Negative Correlated
Q2: Efficiency through Time	Bank Efficiency	Models 1 to 3	Increasing
Nationals and CCC: M2			
Q3: Efficiency & Annual Growth	Bank Efficiency	AGR and ALG	Positive Correlated
Q4: Efficiency & Intermediation	Bank Efficiency	GL/DAL	Positive Correlated
Q5: Efficiency & Asset Quality	Bank Efficiency	Asset Quality	Negative Correlated
Nationals and CCC: M3			
Q6: Efficiency & LAR	CCC Efficiency	LAR	Uncertain
Q7: Efficiency & Asset size	CCC Efficiency	Asset Size	Positive Correlated
Q8: Efficiency & Foreign Banks	CCC Efficiency	Foreign Banks	Positive Correlated
Q9: Efficiency & Equity	CCC Efficiency	Equity	Positive Correlated
Q10: Efficiency & Inflation, GDP, ABS	CCC Efficiency	Adjust CPI, GDP, ABS	Uncertain
Validating National and CCC			
Q11: Efficiency Isotone	Bank Efficiency	Models 1 to 3	Increasing
Q12: Efficiency Ranking	Bank Efficiency	Models 1 to 3	Consistent
Q13: Efficiency & CIR	CIR	Models 1 to 3	Negative Correlated
Q14: Efficiency & ROE	Bank Efficiency	ROE	Positive Correlated
Q15: Efficiency & ROA	Bank Efficiency	ROA	Positive Correlated
Q16: Tripal Ratio & Efficiency	TR1, TR2, TR3	Models 1 to 3	Positive Correlated
Two Australian Banks			
Q17: National & CCC Frontier Scores	National Efficiency	CCC Efficiency	Consistent
Q18: National & CCC Frontier Rankings	National Efficiency	CCC Efficiency	Consistent

Chapter 5: Results & Discussions

The structure for this chapter follows the same order of research question from the previous chapter. As such, consistency is maintained. Section 5.1 presents the results from the three national frontiers and the common frontier. Section 5.2 discusses the differences in efficiency. The validation procedures for all three national frontiers and the common frontier are addressed in section 5.3. Section 5.4 considers the resulting efficiency of the two Australian banks: WPC and ANZ. The final section, 5.5, summarises the key components of this chapter.

There are a few key points to address here in relation to the overall structure of the discussions. Firstly, discussion of the correlations for the national explanatory variables and checkpoints procedures is restricted to the coefficients only. This scope is expanded under the cross country comparison (CCC) or common frontiers to include the statistical significance. This variation is necessary to mitigate the possibilities of over emphasising statistical significance and the expected impact of the small sample as a consequence of fewer observations under the national frontiers.

Finally, section 5.5 binds and summarise the effectiveness of the explanatory variables, and the validating procedures in a slightly different manner. This summary offers a slightly different approach in distinguishing efficient banks from their inefficient counterparts by incorporating both explanatory variables and checkpoint procedures in a simple and direct comparable platform. This approach is independent and devoid of statistical correlations or regressions and yet provides a simplified summary for this chapter while setting the scene for the concluding chapter.

5.1 Resulting Efficiency Scores

The average efficiency scores for all frontiers are presented. It has the comparative scores for both DEA models (CCR and the SBM) across all three banking models. It includes the average efficiency across all DMUs, maximum score (definition is one), minimum score, standard deviation (SD) across all DMUs, and the number of efficient DMUs.

5.1.1 Efficiency Results from the Fijian Frontier

Table 5.1A: Efficiency Results from the Fijian Frontier

FIJI (n=35)	Average Eff Scores	Min Score	Standard Deviation	No. Eff DMUs
Model 1				
CCR	0.76907	0.45432	0.17431	5
SBM	0.64888	0.29624	0.20151	5
Model 2				
CCR	0.90591	0.69424	0.08854	9
SBM	0.75518	0.53327	0.16613	9
Model 3				
CCR	0.93927	0.81012	0.06519	13
SBM	0.81284	0.54700	0.17032	13

Table 5.1B: Average Bank Efficiency Scores from the Fijian Frontier

	CCR 1	**SBM 1**	**CCR 2**	**SBM 2**	**CCR 3**	**SBM 3**
ANZ	0.81255	0.74588	0.94028	0.84114	0.87573	0.68441
WPC	0.90289	0.82517	0.97634	0.92184	0.97264	0.89304
CNB	0.56438	0.46811	0.89024	0.66264	0.88187	0.62410
BOB	0.85529	0.59940	0.85084	0.59168	0.99685	0.98872
HBB	0.71023	0.60587	0.87187	0.75862	0.96925	0.87393
Average	0.76907	0.64888	0.90591	0.75518	0.93927	0.81284

5.1.2 Efficiency Results from the PNG Frontier

Table 5.1C: Efficiency Results from the PNG Frontier

PNG (n=28)	Average Eff Scores	Min Score	Standard Deviation	No. Eff DMUs
Model 1				
CCR	0.81586	0.48617	0.15674	5
SBM	0.63777	0.24924	0.25258	5
Model 2				
CCR	0.90539	0.62537	0.11714	10
SBM	0.81493	0.50507	0.17341	10
Model 3				
CCR	0.92970	0.67733	0.10602	16
SBM	0.85535	0.49510	0.18228	16

Table 5.1D: Average Bank Efficiency Scores from the PNG Frontier

	CCR 1	SBM 1	CCR 2	SBM 2	CCR 3	SBM 3
BSP	0.62136	0.38072	0.77763	0.62307	0.80385	0.63471
ANZ	0.83311	0.64356	0.96074	0.88799	0.96606	0.86768
WPC	0.89996	0.76096	0.94617	0.92440	0.94889	0.91899
MBK	0.90902	0.76582	0.93704	0.82427	1.00000	1.00000
Average	0.81586	0.63777	0.90539	0.81493	0.92970	0.85535

5.1.3 Efficiency Scores from the Samoan Frontier

Table 5.1E: Efficiency Results from the Samoan Frontier

SAMOA (n=25)	Average Eff Scores	Min Score	Standard Deviation	No. Eff DMUs
Model 1				
CCR	0.84819	0.54313	0.13522	5
SBM-C	0.75991	0.41003	0.19341	5
Model 2				
CCR	0.89781	0.63154	0.09966	5
SBM-C	0.76800	0.29752	0.18208	5
Model 3				
CCR	0.94728	0.78277	0.05954	10
SBM-C	0.76061	0.34329	0.23971	10

Table 5.1F: Average Bank Efficiency Scores from the Samoan Frontier

	CCR 1	SBM 1	CCR 2	SBM 2	CCR 3	SBM 3
ANZ	0.97886	0.96087	0.96439	0.90176	0.99450	0.98335
WPC	0.85616	0.79671	0.91917	0.81330	0.93992	0.74482
NBS	0.81879	0.68114	0.89184	0.73660	0.95075	0.69868
SCB	0.65701	0.48169	0.75439	0.50962	0.87143	0.50684
Average	0.84819	0.75991	0.89781	0.76800	0.94728	0.76061

The average efficiency scores are fairly similar in all three countries. This may suggest that relative efficiency among the local banks in each of the three countries is quite similarly distributed.

5.1.4 Efficiency Scores from the Common Frontier

Table 5.1G: Efficiency Results from the Common Frontier

CCC (n=131)	Average Eff Scores	Min Score	Standard Deviation	No. Eff DMUs	Origin of the Eff DMUs
Model 1					
CCR	0.65923	0.22221	0.18990	8	PNG (5) and Solomon (3)
SBM	0.45410	0.02791	0.22379	8	
Model 2					
CCR	0.77008	0.45772	0.14115	11	Solomon (5), PNG (3), Tonga (1), Samoa (1), and Fiji (1)
SBM	0.55688	0.05984	0.19116	11	
Model 3					
CCR	0.85303	0.47257	0.13326	28	PNG (12), Solomon (6), Fiji (4), Tonga (3), and Samoa (3)
SBM	0.62909	0.08701	0.24719	28	

Table 5.1H: Average Country Efficiency Scores from the Common Frontier

	CCR 1	**SBM 1**	**CCR 2**	**SBM 2**	**CCR 3**	**SBM 3**
Fiji	0.61697	0.39396	0.72737	0.46397	0.85174	0.59712
PNG	0.81856	0.63777	0.78157	0.61224	0.86612	0.80113
Samoa	0.5454	0.33303	0.81683	0.54964	0.88509	0.53458
Solomon	0.73111	0.54869	0.7821	0.62096	0.84117	0.66787
Tonga	0.58634	0.36512	0.85275	0.65469	0.92462	0.6561
Vanuatu	0.41297	0.22987	0.52355	0.36543	0.53902	0.26023
Average	0.61856	0.41807	0.74736	0.54449	0.81796	0.58617

The number of efficient DMUs from each model continues to increase and consistent with the three national frontiers but the proportion of 100% efficient DMUs are decreasing significantly. For instance, in model 2 Fiji has 9 efficient out of 35 DMUs (26%), Samoa has 5 out of 25 at 20% , and PNG has 10 out of 28 or 36%, and this common frontier has only 11 out of 131 at 8%. This decreasing proportion of efficient DMUs reflects the impact of the increasing number of observations.

The resulting efficiency scores for the CCR models appear to be more realistic considering the range between maximum and minimum efficiency scores compared to the SBM. However, this is not unusual as by definition SBM ought to vary more as it considers input excess and output shortfall simultaneously and the CCR considers input excess only (at least in this case since the CCR input oriented is used here).

5.1.5 Inefficiency Sources from the Common Frontier

This section is discussed in relation to the weighting (and the optimal solution) for each input and output variable. This is justified as a more comparable platform between the CCR and SBM approaches. Furthermore, the resulting values for the slacks (input excess [s^-] and output shortfall [s^+]) under the SBM approach is not only incomparable against the CCR but the actual values are so miniscule and difficult to interpret coherently. However, the weighting under the SBM does reflect slacks. While this discussion is not commonly included in research publications, it is necessary to investigate each variable contribution towards resulting efficiency. Finally, it provides a justification for the methodology constructs across the two main banking models and the second stage analysis (sections 4.6 and 4.7) is predominantly based around models 2 and 3.

Table 5.1I: Weighting Statistics from the Common Frontier Model 2

CCR 2	TD (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)
Data	0.93612	0.06388	0.82106	0.08873	0.09021
Weighted Data	0.75734	0.24266	0.37674	0.17873	0.21461
SBM 2					
Data	0.93612	0.06388	0.82106	0.08873	0.09021
Weighted Data	0.96499	0.71915	0.46831	0.37141	0.40130

TD is total deposit, NIEX is non-interest expense, GL for gross loan, NIINC is non-interest income, and NTIC is net interest income. The (I) stands for an input variable and (O) is an output variable.

Across the Data row, the two input variables: TD (I) and NIEX (I) reflect the overall average contribution of each input variable towards total input for every DMU across all 131 DMUs *before* the DEA procedures. Similarly, the three output variables: GL (O), NIINC (O), and NTIC (O) show the average contribution of each output variable towards total output for each DMU in the dataset *prior* to DEA. Consequently, the figures in the Data row under both DEA approaches are identical and the sum of both input variables is 100%, so as the sum of all three output variables.

The remaining Weighted Data row summarises the average resulting contribution of each input and output variable towards the optimal solution and resulting efficiency for each DMU across the dataset under the two DEA approaches. Contrary to the previous, the resulting average figures differ significantly between the two DEA approaches, reflecting the variation in the underlying assumptions and procedures, as expected and previously presented in section 4.4.2.2.

In that context, the CCR weighting procedure for the inputs vary significantly from the original data, under the Data row. The optimal weighting for the input variables continues to favour the dominant input TD but reduced to around 75% compared with its original contribution prior to the CCR procedure of 94%. In contrast, NIEX is inflated four times to 24% compared with its original 7%. However, the sum of both input variables average weighted data remains equal to unity, reflecting that this is an input oriented CCR.

The weighted data for the output variables continue to favour the dominant output variable, GL at 38%, which is a significant reduction from its pre-CCR status of 82%. This is followed by NTIC with 21% then NIINC at 18%. The last two variables account for a significant portion (over 50%) of the resulting efficiency scores despite their combined original contribution (pre-CCR) is less than 20%. The sum of the output weighted data is the resulting efficiency of 77.008%, which is the average efficiency score for the CCR 2 in Table 5.1G. These results suggest that CCR efficiency under this model is largely dominated by the two smaller output variables, although the smaller input variable, NIEX also contributes above its original weight.

Under the SBM, the optimal weighting procedure corresponds with the input excess for the input variables and output shortfall for the output variables. The dominant input variable, TD continues to dominate but marginally higher at 97%. The second input NIEX has exploded to 72%, twelve times its original weight. Consequently, TD remains the main source of input excess but NIEX accounts for just as much input excess despite its original contribution of a mere 7% towards total input.

For the output variables, GL remains the main source of output shortfall (47%), followed by NTIC (40%) then NIINC (37%). The last two variables' increasing contribution toward output shortfalls is surprising, despite their lesser contribution to total output. The sum of all input weighted data is 1.68414, and the total output weighted data is 1.24102, reflecting that neither weighted input nor weighted output equals to unity. Inefficiency is the total input excess minus output shortfall, 0.44312, hence, efficiency is 0.55688, which is the average efficiency score for the SBM 2 in Table 5.1G.

The overall verdict for the construction of model 2 is surprising. Under this CCR input orientation, the dominant GL output variable is significantly less influential in determining bank efficiency, despite its sheer dominance prior to the CCR procedure. This result is also evident under the SBM approach. Therefore, both DEA approaches suggest that bank efficiency is largely determined by the smaller variables and posing some concerns regarding the reliability of accounting procedures and profitability performance measures, bear in mind that the smaller variables provide the foundation for realised profits.

Table 5.1J: Weighting Statistics from the Common Frontiers Model 3

CCR 3	DAL (I)	NIEX (I)	GL (O)	NIINC (O)	NTIC (O)	OEA (O)
DATA	0.93009	0.06991	0.59648	0.05997	0.05830	0.28525
Weighted Data	0.81706	0.18294	0.43551	0.17372	0.08779	0.15600
SBM 3						
DATA	0.93009	0.06991	0.59648	0.05997	0.05830	0.28525
Weighted Data	5.86564	2.68315	1.28677	0.87428	0.48723	5.52961

DAL is deposit available for loan, and OEA is other earning assets. The (I) stands for an input variable and (O) is an output variable.

The discussion for model 3 follows the same procedure as in model 2. The Data row under the CCR remains identical to the SBM 3, and the variation in the Weighted Data between both DEA approaches is even more evident.

Under the CCR 3, the input optimal weighting continues to favour the dominant input DAL but at 10% less than its original weight. NIEX weighting is doubled compared with its original contribution to overall input. The output weighting for the most dominant GL variable accounts for the major source of efficiency; this is followed by NIINC at 18%, and three times its original weight. The OEA variable is 16%, a reduction by about half of its original weight, leaving NTIC as the least source of efficiency, almost proportional to its original weight. The sum of the output weighted data is 85.3%, which is the average efficiency score for the CCR 3 in Table 5.1G.

SBM 3 continues to suggest that the dominant input DAL is the main source of input excess and accounting for twice the input excess of NIEX, despite NIEX contribution to the overall input being less than 7%. Output shortfall is dominated by OEA at 5.53 despite its original 0.29 contribution, this is followed by GL at 1.29 compared to its original larger share of 0.60, and NIINC is 0.87, which is 14 times its original 6% share. NTIC weighting is 0.49 compared with its original 0.6. The most surprising observation is the OEA variable. It accounts for over four times output shortfall compared with GL despites OEA original contribution to overall output is less than half of GL. The total input excess is 8.54879 and output shortfall is 8.17789, hence, inefficiency is 0.37001 and the average efficiency score is 62.91%, which is the average efficiency score for the SBM 3 in Table 5.1G.

The conclusion for the construction of model 3 is even more surprising than model 2. Firstly, the resulting optimal weighted data for DAL and OEA in the SBM (and not in the CCR) are unusually high but they share the common ground in liquidity requirements: the former is adjusted to the impact of statutory deposits and the latter accounts for the liquid assets that banks are required to hold under liquidity requirements. Secondly, the dominance of OEA over GL under the SBM is puzzling considering the sheer size of GL prior to the SBM and this trend is not found under the CCR. Therefore, the decision to explore the impact of liquidity requirements in model 3 and not model 2 is strongly confirmed, liquidity requirements are the dominant source of input excess and output shortfall, and for smaller economies, liquidity requirements is perhaps the main source of bank efficiency or inefficiency.

5.2 Explanatory Variables: Results and Discussions

This discussion follows the same order of research questions from the previous chapter. The scope of the discussion incorporates the correlations and trends from all three national frontiers, as well as the common frontier. This comparison does not assume that bank efficiency variations across the four frontiers ought to be comparable (efficiency is a relative measure and comparability across different samples are not reasonable), however, the emphasis is leaning towards the purpose of triangulation.

5.2.1 Q1: Is CAR relevant in explaining technical and scale efficiency?

The impact of CAR in technical and scale analysis is considered in Fiji and PNG only where the annual CAR level for each bank is disclosed. The exclusion of Samoa (and the rest) is due to the unavailability of such data.

The discussion starts with the comparable levels of technical and scale efficiency from the common frontier in both models 2 and 3. This is followed by the correlation between technical and scale efficiency from the common frontier, model 3. The correlations between CAR and the two efficiency concepts are based on models 2 and 3, previously explained in section 4.6.1. Consequently, the correlation from the national and the common frontiers are presented.

Table 5.2A: Average Regional Technical and Scale Efficiency: Common Frontier

	Fiji	PNG	Samoa	Solomon	Tonga	Vanuatu	Average
Model 2							
Technical	0.7274	0.7816	0.8168	0.7821	0.8528	0.5236	0.7474
Scale	0.9111	0.5937	0.7180	0.7399	0.6974	0.9568	0.7695
Model 3							
Technical	0.8517	0.8661	0.8851	0.8412	0.9246	0.5390	0.8180
Scale	0.9201	0.6360	0.7269	0.7347	0.7143	0.9773	0.7849

Technical refers to technical efficiency and Scale is scale efficiency. Data on the average column is simply the regional average across the six countries.

Berger et al (1993a) suggest that average scale inefficiency in banking is around 5% and 20% for technical efficiency. Model 2 suggests that the average scale inefficiency in this dataset is around 23% and technical inefficiency is 25%. In PNG, Samoa, Solomon, and Tonga, technical efficiency dominates scale efficiency. On the other hand, Fiji and Vanuatu reverse the trend by being more scale efficient than technical efficient. This result is suggesting that for this intermediation banking model, the average commercial banks' scale efficiency in the region is about 2% ahead of the average technical efficiency and consistent with Al Shamsi et al (2009) based on a study of banks in the United Arab Emirates.

Model 3 shows an improvement in technical inefficiency to less than 20% and scale inefficiency is marginally unchanged at 22%. The marginal jump in technical efficiency (significantly less on scale efficiency) in model 3 compared with model 2 is attributed to the isotonic property of efficiency, previously explained in section 4.7.1 and discussed in section 5.3.1. In PNG, Samoa, Solomon and Tonga, technical efficiency dominates scale efficiency. In contrast Fiji and Vanuatu continue to be more scale efficient than being technical efficient. In that context, the comparable levels of technical and scale efficiency across countries remain consistent between the two banking models. However, the average commercial banks' technical efficiency marginally dominates scale efficiency.

It is evident that the average level of technical and scale efficiency is a contrast with Berger at al (1993a) findings. However, these finding are based on small economies compared with Berger et al, where the results are based on larger and developed economies. Moreover, PNG is the least scale efficient country in both banking models, reflecting the geographic challenges faced by local banks in delivering banking services (section 1.5). Furthermore, Vanuatu's dominance in scale efficiency (despite being the least technically efficient) on both banking models may account for its dominance in bank assets per capita across the region (section 1.5). Finally, these observations could be attributed to the small number of banks in the region and a reflection of the differences in input and output specifications.

Despite the regional variation in the levels of technical and scale efficiency, the correlation between technical and scale efficiency is quite strong at 46.20% (model 3, common frontier), the coefficient is positive, and highly statistically significant ($p<0.001$) for all DMUs. In that, technically efficient banks are more likely to be scale efficient and technically inefficient banks are expected to be scale inefficient.

Table 5.2B: Correlations between CAR, Technical and Scale Efficiency: All Frontiers in Models 2 and 3

CAR	Fiji		PNG		CCC	
	Tech	Scale	Tech	Scale	Tech	Scale
Model 2	-3.9%	-8.2%	17.3%	17.0%	22.5%	15.0%
P-Values	0.825	0.640	0.378	0.388	0.076	0.240
Model 3	34.2%	32.1%	37.6%	32.8%	38.7%	34.5%
P-Values	**0.044**	0.060	**0.049**	0.089	**0.002**	**0.006**

Tech refers to technical efficiency and Scale is scale efficiency.

CAR across the six countries is discussed in chapter 3. The expected result for Q1 is explained in section 4.6.1, suggesting that CAR ought to be negatively correlated with both technical efficiency (CCR) and scale efficiency (CCR/BCC).

The average CAR for the all banks in Fiji is 12% for the seven year period compared with 41% in PNG. Technical efficiency is fairly similar in both countries across models 2 and 3. On the other hand, scale efficiency is significantly higher for Fiji compared with PNG in both models. This evidence alone is suggesting a possible inverse relationship between CAR and scale efficiency. However, the correlation between CAR and technical efficiency from the national frontiers is positive and statistically significant ($p<0.05$) in both countries in model 3. Conversely, the correlation between CAR and scale efficiency is not statistically significant in both countries across the two models.

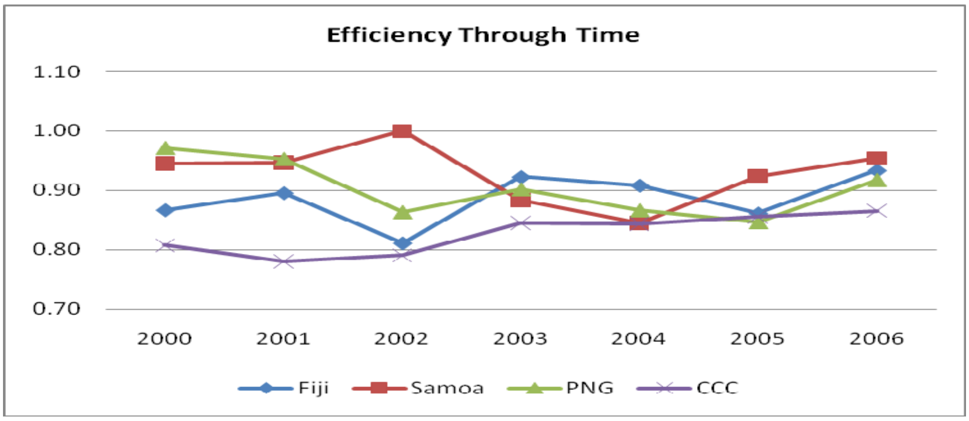
In PNG, MBK's average CAR for the seven year period is unusually high at 103%, highest in 2006 (156%), and lowest in 2002 (70%). This outlier bank was removed from the PNG and CCC analysis for model 2 and both led to a negative correlation in both technical and scale with CAR, thereby consistent with Fiji but it was statistically insignificant on both occasions.

Under the common frontier, CAR is positively correlated with both technical and scale efficiency. The correlations are stronger in model 3 compared with model 2, where the p-values ($P<0.05$) are statistically significant. The dominance of model 3 over model 2 is unexpected and a contradiction to the Q1 expectation. However, this evidence could well suggest that the risk weighted assets components of the CAR are better captured by model 3 and not model 2.

Therefore, the expected negative impact of CAR in technical and scale efficiency is contradicted, since the results are suggesting a positive correlation. Moreover, CAR's impact on technical efficiency appears to dominate the expected impact on scale efficiency, as evident from the comparable value of the correlations, as are the level of statistical correlations. However, this conclusion may differ if the data on CAR are obtained for the rest of the four countries in the dataset.

5.2.2 Q2: Does efficiency improve through time?

Figure 15: Efficiency through time from all four Frontiers



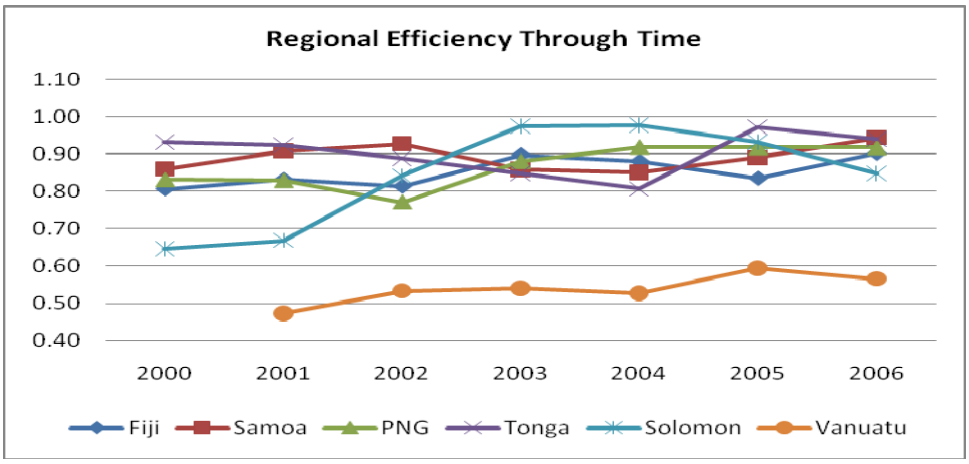
The change in efficiency through the seven year period is presented in Figure 15 and Figure 16 and the average efficiency scores from the CCR in model 3 since it addresses the overall technical efficiency of the commercial banks. The efficiency score for each year is the average score for all commercial banks.

The three national frontiers suggest that efficiency through time varies more than the CCC. All three countries are relatively efficient in 2000, declining since 2001 before improving towards 2006. The only significant variation across the three national frontiers is that, efficiency movements in Fiji and PNG are fairly similar, whereas Samoa is more dissimilar and most evident in 2002 where the former countries' efficiency drops, Samoa increases. The only explanation for the 2002 variation is the change in the banking structure in PNG following BSP's acquisition of the PNG Banking Corporation and ANZ taking over Bank of Hawaii. Similarly, ANZ also taking over BOH in Fiji. Restructing could also be explained by the Samoa's decline in 2003, following the entrance of Samoa Commercial Bank. In that context, acquisitions seem to trigger a short term decline in efficiency and the entrance of a new bank is followed by a longer and persistent decline in efficiency.

Finally, the variation in efficiency through time for all commercial banks from the common frontier is smoother than all three national frontiers. This is not surprising since the sample size is significantly larger. However, the CCC delines marginally in

2001, reflecting the exit of BOH operations from the region. Finally, the commercial banks' efficiency through time is improving, as shown by the CCC frontier.

Figure 16: Regional Efficiency through Time from the Common Frontier



Fiji and PNG continues to move side by side, and Samoa is more dominant in the first three years, showing signs of relative inefficiency in 2003 and 2004 before finishing 2006 marginally ahead. Tonga and Solomon appear to be most volatile with relatively larger swings in efficiency, although, Solomon is most prominent starting at over 60% in 2000, climb to almost fully efficient in 2003 and 2004 before dropping to over 80% in 2006. Finally, Vanuatu continues to be the least efficient country. However, data for Vanuatu is only for the National Bank of Vanuatu and may not reflect the overall efficiency of all local commercial banks.

5.2.3 Q3: Could efficiency be explained by asset and loan growth?

Table 5.2C: Correlations between Growth and Efficiency: All Frontiers

	Fiji		PNG		Samoa		CCC	
	CCR-2	SBM-2	CCR-2	SBM-2	CCR-2	SBM-2	CCR-2	SBM-2
Asset	1.64%	-19.45%	-28.13%	-73.12%	-66.21%	-39.87%	-6.1%	-5.2%
P-Values	0.925	0.263	0.147	**0.000**	**0.000**	**0.036**	0.491	0.555
Loan	30.99%	2.97%	-17.00%	-64.35%	-60.54%	-12.77%	7.8%	7.6%
P-Values	0.070	0.866	0.387	**0.008**	**0.005**	0.517	0.373	0.386
	CCR-3	SBM-3	CCR-3	SBM-3	CCR-3	SBM-3	CCR-3	SBM-3
Asset	-26.08%	-30.37%	-31.13%	-51.71%	-54.04%	-41.17%	-1.8%	-2.8%
P-Values	0.130	0.076	0.107	**0.008**	**0.005**	**0.030**	0.836	0.751
Loan	-27.23%	-41.32%	-19.72%	-47.82%	-53.09%	-23.36%	3.6%	-3.7%
P-Values	0.114	**0.014**	0.314	**0.016**	**0.006**	0.232	0.680	0.679

The expected trend for this question is that both annual growth in assets and loans should be highly and positively correlated with efficiency. The evidence is suggesting otherwise.

In Fiji, high growth in asset has very little but negative correlation with efficiency and the coefficients are stronger in the SBM. Annual loan growth seems to be positively correlated and but slightly weaker for the SBM models. The resulting correlations from Samoa are much stronger and more consistent but efficiency is negatively correlated with both asset and loan growth. This strong correlation is consistent with the bank's average, where ANZ has the least growth in assets and loans while it is most dominant in the efficiency of both. On the other hand, SCB dominates the annual average growth in assets and loans but is least efficient in both. This trend is consistent with the remaining two banks. In PNG, the correlations are closer to Samoa but not quite as strong. Most notable are the BSP results, where superior growth in both assets and loans are associated with the lowest resulting efficiency scores on both the CCR and the SBM.

Furthermore, the resulting correlations in Samoa and PNG suggest that annual asset growth are stronger correlated with efficiency compared with the growth in loans, although Fiji reverses the trend. A possible explanation for this scenario is that both Samoa and PNG share a relatively higher CAR at 15% and 12% respectively compared with the 8% in Fiji. Hence, the correlation with loan growth is weaker than assets growth in Samoa and PNG and vice versa in Fiji. Furthermore, the main driver of growth in Samoa is the newly established commercial bank: SCB. In PNG, BSP is the most dominant in assets and loan growth reflecting its ongoing acquisitions. Consequently, these two banks are operating in transition, relatively inefficiently, and efficiency may improve once they both settle.

In conclusion, this conflicting and unexpected finding could also suggest that perhaps achieving higher annual growth in assets and loans might not be consistent with achieving banking efficiency.

In relation to the results from the CCC, annual asset growth is negatively correlated with efficiency at both the DMU level and the average bank level. However, all correlations are statistically insignificant.

Finally, the CCC does not contradict the results from the three national frontiers. Hence, the conclusion remains: growth in assets and loans are not implying improving efficiency. However, increasing growth in both variables through acquisitions could suffocate efficiency, at least in the short run.

5.2.4 Q4: Does efficiency correlate with intermediation?

Degree of intermediation is measured by the GL/DAL ratio. DAL and GL are the dominant variables in model 3. Consequently, efficiency from model 2 is applied to this investigation and not model 3, otherwise correlations would be a product of interactions between these two variables.

Table 5.2D: Correlations between Intermediation and Efficiency: All Frontiers

	Fiji		PNG		Samoa		CCC	
	CCR-2	SBM-2	CCR-2	SBM-2	CCR-2	SBM-2	CCR-2	SBM-2
GL/DAL	38.42%	38.83%	48.25%	43.11%	8.81%	-0.39%	38.6%	23.8%
P-Values	**0.023**	**0.021**	**0.009**	**0.002**	0.675	0.986	**0.000**	**0.006**

The expectation for this question is a positive correlation between intermediation and efficiency. It is strongly supported in Fiji and PNG but less convincing in Samoa.

In Fiji, intermediation is strong and positively correlated with efficiency. WPC dominates the intermediation and has the highest efficiency compared to BOB, which has the lowest intermediation and is least efficient on both the CCR and SBM.

This evidence is also supported from PNG at 50%. ANZ dominates the intermediation and efficiency, while BSP has the lowest intermediation ratio and least efficient in both DEA models.

In Samoa, the relationship remains positive but much weaker at 8%. This evidence could be explained by the fact that the two locally owned banks dominate the intermediation ratio (NBS at 102% and SCB at 96%). Relatively younger players in the banking market are perhaps still learning to manage their respective costs accordingly. This evidence echoes the result from question 2; however, the difference is the impact following the entrance of the SCB appears to be more prolonged than the resulting short term decline in efficiency due to acquisition.

Finally, the result from Samoa is unusual since it has the highest CAR and yet continues to intermediate more than commercial banks in Fiji and PNG. In that, the evidence is suggesting that intermediation in Samoa is relatively inefficient compared to their neighbours and this question can be better explained later under the CCC frontier.

In the CCC context, the correlation is strong positive and statistically significant. Therefore, the relationship between intermediation and efficiency is strongly supported and confirming that a higher degree of intermediation leads to higher efficiency.

5.2.5 Q5: Does efficiency reflect asset quality?

Table 5.2E: Correlations between Asset Quality and Efficiency: All Frontiers

	Fiji		PNG		Samoa		CCC	
	CCR-2	SBM-2	CCR-2	SBM-2	CCR-2	SBM-2	CCR 2*	SBM 2*
PDD/GL	-9.78%	13.38%	-5.27%	-18.03%	-2.93%	-3.46%	-15.1%	-7.5%
P-Values	0.576	0.444	0.790	0.359	0.889	0.870	0.086	0.392
BDD/PDD	-36.74%	-69.51%	-40.40%	-38.45%	-74.20%	-70.91%	0.2%	-14.0%
P-Values	**0.030**	**0.000**	**0.033**	**0.043**	**0.000**	**0.000**	0.984	0.112
	CCR-3	SBM-3	CCR-3	SBM-3	CCR-3	SBM-3	CCR **	SBM **
PDD/GL	17.80%	13.02%	19.67%	22.63%	3.14%	-4.24%	-19.7%	-10.3%
P-Values	0.306	0.456	0.316	0.247	0.881	0.841	0.406	0.665
BDD/PDD	-21.21%	-19.86%	-37.16%	-23.53%	-63.52%	-50.29%	4.4%	-23.3%
P-Values	0.221	0.253	0.052	0.228	**0.001**	**0.010**	0.858	0.323

The correlation and p-value between the two ratios in Fiji (-46.5%, 0.005), Samoa (-18.6%, 0.374), and PNG (16.2%, 0.409) and under the CCC, the CCR* and SBM* results are based on the DMU basis, and the CCR** and SBM** are on model 2 Banks' average basis.

The expected correlation between the asset quality ratios and efficiency are negative and they are both supported by the result. However, the loan provision ratio is less convincing compared to the loan losses ratio.

The average loan provisions are highest in Fiji, followed by PNG, then Samoa and the correlation with the resulting efficiency scores is reflected accordingly at -10% in Fiji, -5%, in PNG, and -3% in Samoa. Moreover, loan provisions are also inversely related to the prescribed level of CAR: Fiji has the lowest CAR (8%) followed by PNG (12%) then Samoa (15%) and the average loan provision by all local commercial banks is highest in Fiji, followed by PNG then Samoa.

However, the stronger correlation between current loan losses (BDD/PDD ratio) and efficiency is very encouraging compared to the loan provisions, as this evidence strongly confirms the direct link between effectively managing banking assets through the loan portfolio and efficiency as a concept.

The implication for this question can be best explained by the results from Samoa. The average loan provision for all commercial banks is 4.57%, which is less than PNG (5.69%) and Fiji (6.20%). The annual allowances for loan losses plus the actual loan losses amount to over 30% of the total loan provisions, which is marginally higher than Fiji at 29% and PNG at 17%.

For the CCC, the resulting correlation between the future loan losses and efficiency is consistently negative at both the DMU and average bank level, although it is marginally stronger at the latter despite the statistical insignificance. The current loan loss ratio correlation is also negative (despite the minimal positive from the CCR-2 model) and even stronger than the loan provision ratio, although the statistical significance is not confirmed and is even less so on the average bank level compared to the DMU level.

These two measures of asset quality suggest that asset quality is negatively correlated with banking efficiency and consistent with Resti (1997) and Berger & DeYoung (1997). Efficient banks are most likely to successfully manage banking risk better compared with their less efficient counterparts.

5.2.6 Q6: What is the impact of LAR on Efficiency?

Table 5.2F: Correlations between LAR and Efficiency: All Frontiers

	Fiji		PNG		Samoa		CCC	
	CCR-3	SBM-3	CCR-3	SBM-3	CCR-3	SBM-3	CCR-3	SBM-3
LAR 1/TA	-8.71%	-0.24%	22.78%	21.46%	-22.59%	-29.87%	-18.9%	-34.0%
P-Values	0.619	0.989	0.244	0.273	0.278	0.147	**0.031**	**0.000**
LAR 2/TA	32.76%	50.77%	18.94%	35.62%	28.40%	41.03%	-6.1%	27.4%
P-Values	0.055	**0.002**	0.334	0.063	0.169	**0.042**	0.487	**0.002**

The expected finding for this question is an uncertainty but possibly a negative relationship between liquid assets and efficiency. The average LAR 1 for all commercial banks in these three countries is fairly even: 10% in Fiji, 12% in Samoa, and 10% in PNG. On the other hand, the average LAR 2 is much higher in PNG at 60% compared to 40% in Fiji and 24% in Samoa. The high ratio in PNG reflects the 25% LAR imposed on the commercial banks by the BPNG compared to no formal LAR in the other two countries. Despite this variation, it reflects the efforts by commercial banks to hold liquid assets to counter liquidity risk.

LAR 1 is statistically insignificant and the correlations are weak, although positive in Fiji and Samoa and negative in PNG, reflecting the latter's existing formal liquidity requirement, however it is a component of LAR 2. LAR 2 is positively correlated with efficiency in all three countries, strongest in Fiji followed by Samoa, where it is statistically significant under the SBM ($p<0.05$). It is surprising that the correlation is higher in Samoa and Fiji compared to PNG, where the result is expected to be strongest.

In conclusion, liquid assets do impact upon bank efficiency. Whether a formal LAR is preferred over an informal LAR, the SBM seems to support that argument and less convincing under the CCR results. However, the answer regarding formal versus informal LAR should be better explained later from the CCC frontier.

For the CCC, the correlation between LAR 1 and efficiency is consistently negative. This finding is even stronger compared with the results from the national frontiers. The result for LAR 2 is inconsistent. The CCR based models suggest the correlation is negative, while the SBM based models are suggesting the opposite. However, the correlations from the SBM models are consistent with the results from the three national frontiers, and it is statistically significant ($p<0.05$).

The concluding remark for the most likely impact of LAR in efficiency is based on the SBM and not the CCR. This unusual step is based on the notion that LAR affects both input and output variables, through deposits available for loans as an input and other earning assets as an output respectively.

The remaining issue is whether formal LAR is preferred over informal LAR for small economies. The resulting evidence from PNG (is most efficient under SBM) where formal LAR is highest compared with Fiji and Samoa where LAR is informally prescribed. This may suggest that formal LAR promotes banking efficiency, at least for small economies. LAR for Tonga and the Solomons are formally prescribed but at a lesser level compared with PNG and their resulting efficiency scores from the SBM 3 are higher than Fiji and Samoa but lower than PNG (Vanuatu continues to be excluded from this discussion as it is based only on one bank).

5.2.7 Q7: Does Asset size affect efficiency?

Table 5.2G: Assets Size and Efficiency: Common Frontier

	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
Large Banks	0.70846	0.82584	0.86791	0.50459	0.64816	0.68760
Small Banks	0.58783	0.73134	0.87674	0.38050	0.45807	0.59209
CCC Average	0.64543	0.77293	0.85500	0.44122	0.55799	0.62803

The three large banks are made up of the two Australian owned (WPC and ANZ) commercial banks and the PNG based BSP. The performance of these three banks is critical for the stability of the banking systems in the region as they account for over 80% of banking assets. Fortunately, these three banks not only dominate the banking markets but they are also proven to be more efficient compared with their smaller counterparts. Large banks are most dominant in models 1 and 2. The remaining model 3 is fairly even between the two groups with the only exception is the result from the SBM, suggesting that that large banks are about 10% more efficient than the small banks.

Finally, superior efficiency of large banks is consistent with Schure et al (2004). On the other hand, Kwan (2006), Drake & Hall (2003), and Allen & Rai (1996) find that small banks are more efficient. Siems & Barr (1998) results contradict both by suggesting that no difference between the efficiency of large and small banks.

5.2.8 Q8: Are foreign banks more efficient than locally owned banks?

Table 5.2H: Foreign banks and Efficiency: Common Frontier

	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
Foreign Banks	0.71717	0.84732	0.88468	0.51697	0.67240	0.70274
Local Banks	0.59155	0.71798	0.85712	0.38052	0.45226	0.58589
CCC Average	0.64543	0.77293	0.85500	0.44122	0.55799	0.62803

Foreign ownership of banking assets are a common feature of small banking systems and for that reason, the definition of foreign ownership is restricted only to the two Australian owned banks (ANZ and WPC), otherwise there won't be any feasible number of banks left that are truly locally owned (except the two small banks in Samoa: NBSI and SCB) except BSP from PNG. In that context, foreign banks dominate the rest in all models. This dominance is around 10% difference in efficiency in models 1 and 2, and fairly even in model 3.

Dominant efficiency of foreign banks is consistent with Havrylchyk (2006), Bonin et al (2005), Weill (2004), and Leightner & Lovell (1998). On the other hand, other studies find foreign banks to be less efficient compared with local counterparts such Zajc (2006) and Bos & Kool (2001).

5.2.9 Q9: Does equity promote efficiency?

Table 5.2I: Correlations between Equity and Efficiency: Common Frontier

DMUs	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
Equity/TA	27.4%	24.0%	31.8%	32.8%	32.8%	39.7%
P-Values	**0.002**	**0.006**	**0.000**	**0.000**	**0.000**	**0.000**

The obvious trend from this table is the positive correlation between equity and efficiency from all banking models, and the correlations are all extremely statistically significant, where all p-values are less than 1% ($p<0.01$). The slight dominance of model 3 in its value of the coefficient suggests that it is more directly related to equity compared to the other models. This finding is surprising as we expect model 2 to be better related to equity than model 3 due to the fact that the former model focuses more on the degree of intermediation, where equity, through the CAR requirements ought to confirm that link.

Despite the strong correlation of equity and efficiency, the exclusion of equity from the deterministic component of DEA under this analysis is best explained by Berger & Mester (1997). They suggest that equity can favour large commercial banks by virtue of its being built up over the years. In this context, small local banks can also be severely disadvantaged primarily based on foreign large banks ability to be publicly listed, thereby shareholders can access and liquidate banking shares while local shareholders are further disadvantaged by the relatively higher CAR.

5.2.10 Q10: Could efficiency be affected by macro-economic variables?

Table 5.2J: Regression outputs between Efficiency and macro-economic variables: Common Frontier

CCR 3	Coef	SE Coef	T	P
Constant	-0.1272	0.3251	-0.39	0.701
log (INF)	0.3025	0.1228	2.46	**0.026**
log (GDP)	0.3843	0.1328	2.89	**0.011**
log (ABS)	-0.1470	0.0944	-1.56	0.139

R-Sq = 45.8%   R-Sq (Adj) = 35.6% and P = **0.018**

SBM 3	Coef	SE Coef	T	P
Constant	0.5950	0.7077	0.84	0.413
log (INF)	0.1200	0.2674	0.45	0.660
log (GDP)	0.3249	0.2890	1.12	0.277
log (ABS)	-0.3745	0.2054	-1.82	0.087

R-Sq = 26.1%   R-Sq (Adj) = 12.3% and P = 0.172

The regression output from the CCR appear to be superior to the SBM since the explained variations (both r-square and adjusted r-square) are higher and the regression model's p-value is significant at 0.018 ($p<0.05$).

Inflation and GDP both share the same positive sign and are statistically significant ($p<0.05$) compared with the ABS variable that is negative but statistically insignificant.

In regards to the GDP, increasing GDP per capita promotes higher banking efficiency, consistent with Vivas & Pastor (2006). Consequently, lower GDP is most likely to be associated with lower banking efficiency. This is consistent with expectation and economically relevant as the commercial banks are more like to intermediate more when economic conditions are favourable. More importantly, the cost of intermediation is most likely to be increasingly efficient at such favourable economic conditions due to the expected less volume of credit default and perhaps credit risk.

However, in relation to inflation it may be alarming to be identified as being positively related to bank efficiency (like GDP) but in the context of small economies, this is not entirely unusual. This evidence signals a feature of small economies previously discussed earlier, as more of a consumption based as opposed to the developed countries where we expect more production. However, it is also more likely that this observation further suggest that GDP and inflation are highly interacting.

Finally, ABS is surprisingly negatively related with banking efficiency. While this variable is statistically insignificant under the CCR, it is the only variable to be close to being statistically significant under the SBM. This finding suggests that increasing commercial banking assets per capita is most likely to compromise banking efficiency. This result is unusual and perhaps economically unsound. However, one possible explanation for this phenomenon is the absence of banking competition in the region. Perhaps the monopolistic nature of banking environment gives rise to the resulting negative impact in banking efficiency.

5.3 Validating Procedures

The structure for this section maintains the same consistency as the previous. The order of the research questions from the previous chapter is followed accordingly.

5.3.1 Q11: Are efficiency scores Isotonic?

Table 5.3A: Average Efficiency Scores from all four Frontiers

Model	FIJI	PNG	Samoa	CCC
CCR 1	0.76907	0.81586	0.84819	0.65923
CCR 2	0.90591	0.90539	0.89781	0.77008
CCR 3	0.93927	0.92970	0.94728	0.85303
SBM 1	0.64888	0.63777	0.75991	0.45410
SBM 2	0.75518	0.81493	0.76800	0.55688
SBM 3	0.81284	0.85535	0.76061	0.62909

The expectation for this question is strongly supported from all three national frontiers, and the common frontier. The average efficiency score from the CCR model is consistently increasing from model 1 to 2, and then to model 3. This trend is also supported by the SBM, although the average efficiency for Samoa between models 2 and 3 is marginally static.

5.3.2 Q12: Is efficiency consistently measured between banking models?

Table 5.3B: Consistent Ranking of Banks' Efficiency: Fijian Frontier

	Model 1		Model 2		Model 3		Ranking	
	CCR	SBM	CCR	SBM	CCR	SBM	CCR	SBM
ANZ	0.81255	0.74588	0.94028	0.84114	0.87573	0.68441	3-2-5	2-2-4
WPC	0.90289	0.82517	0.97634	0.92184	0.97264	0.89304	1-1-2	1-1-2
CNB	0.56438	0.46811	0.89024	0.66264	0.88187	0.62410	5-3-4	5-4-5
BOB	0.85529	0.59940	0.85084	0.59168	0.99685	0.98872	2-5-1	4-5-1
HBB	0.71023	0.60587	0.87187	0.75862	0.96925	0.87393	4-4-3	3-3-3
	Resulting Ranking Variation						16	10

The efficiency ranking reflects the corresponding ranking of the individual banks. A rank of 1 is assigned to the most efficient bank and the highest number reflects the least efficient bank. In the respective CCR and SBM column, the first digit is the ranking for model 1, second and third digit are for models 2 and 3. The resulting average ranking variation reflects the overall misranked for that respective DEA model.

Table 5.3C: Consistent Ranking of Banks' Efficiency: PNG Frontier

	Model 1		Model 2		Model 3		Ranking	
	CCR	SBM	CCR	SBM	CCR	SBM	CCR	SBM
BSP	0.62136	0.38072	0.77763	0.62307	0.80385	0.63471	4-4-4	4-4-4
ANZ	0.83311	0.64356	0.96074	0.88799	0.96606	0.86768	3-1-2	3-2-3
WPC	0.89996	0.76096	0.94617	0.92440	0.94889	0.91899	2-2-3	2-1-2
MBK	0.90902	0.76582	0.93704	0.82427	1.00000	1.00000	1-3-1	1-3-1
	Resulting Ranking Variation						7	8

Table 5.3D: Consistent Ranking of Banks' Efficiency: Samoan Frontier

	Model 1		Model 2		Model 3		Ranking	
	CCR	SBM	CCR	SBM	CCR	SBM	CCR	SBM
ANZ	0.97886	0.96087	0.96439	0.90176	0.99450	0.98335	1-1-1	1-1-1
WPC	0.85616	0.79671	0.91917	0.81330	0.93992	0.74482	2-2-3	2-2-2
NBS	0.81879	0.68114	0.89184	0.73660	0.95075	0.69868	3-3-2	3-3-3
SCB	0.65701	0.48169	0.75439	0.50962	0.87143	0.50684	4-4-4	4-4-4
	Resulting Ranking Variation						2	0

SBM dominates the CCR in ranking consistency in all three countries. This is most evident in Samoa where the SBM model correctly ranks all four commercial banks across all three different banking models. The implication for this finding is to suggest that perhaps the SBM is better equipped to measure efficiency consistently from different models compared with the CCR, where it addresses one dimension at the time only (input excess or output deficiency), and the SBM accounts for both simultaneously. However, this finding is based on a very small number of banks and may not be valid when the number increases.

Table 5.3E: Consistent Ranking of Banks' Efficiency: Common Frontier

	Model 1		Model 2		Model 3		Ranking	
	CCR	SBM	CCR	SBM	CCR	SBM	CCR	SBM
Fiji	0.61697	0.39396	0.72737	0.46397	0.85174	0.59712	3-5-4	3-5-4
Samoa	0.5454	0.33303	0.81683	0.54964	0.88509	0.53458	5-2-2	5-4-5
PNG	0.81856	0.63777	0.78157	0.61224	0.86612	0.80113	1-4-3	1-3-1
Tonga	0.58634	0.36512	0.85275	0.65469	0.92462	0.6561	4-1-1	4-1-3
Solomon	0.73111	0.54869	0.7821	0.62096	0.84117	0.66787	2-3-5	2-2-2
Vanuatu	0.41297	0.22987	0.52355	0.36543	0.53902	0.26023	6-6-6	6-6-6
	Resulting Ranking Variation						16	14

Table 5.3E presents the summary of the resulting efficiency scores for each country under three banking models. It shows the average commercial banks in Fiji, PNG, and Samoa and their corresponding average efficiency over the seven year period.

The ranking of the average country efficiency is not quite as consistent as earlier found in the national frontiers. SBM continues to dominate the CCR model. However, Vanuatu is consistently ranked least efficient by both DEA models across all three banking models. However, we have to bear in mind that the resulting average efficiency scores for Vanuatu is based only on one bank: NBV while the rest of the other countries are the combined average of all the commercial banks.

The implications of this country ranking are potentially useful in explaining why some countries dominate in certain banking models and not in all models. In model 1, PNG and Solomon dominate the resulting efficiency scores in both CCR and SBM models. This dominance reflects the higher interest margin commercial banks appreciates in their respective region and consistent with Matthews and Tripe (2004). The interest margin is highest in the Solomon at 14% followed by PNG at 10% (although Vanuatu is marginally trailing at 9%, the result from Vanuatu is based on one bank and though perhaps unable to play a part in this comparison, bear in mind it is the least efficient in all three banking models). Furthermore, the remaining three countries' (Fiji, Samoa, and Tonga) efficiency scores do not signal their respective interest margin in any consistent manner.

For model 2, Tonga and Samoa dominate efficiency scores, driven by a stronger intermediation (GL/DAL ratio) at an average of 97% and 90% respectively. This result is slightly unusual considering that Samoa's CAR is 15% throughout the entire seven year period and Tonga's CAR was 15% until 2004 before dropping back to the commonly practiced 8% level. On the other hand, Fiji has consistently applied the 8% CAR level through out, although the number of commercial banks is highest in Fiji, economic development is stronger, and perhaps the banking industry is more competitive than elsewhere in the region.

The results for model 3 are consistent with model 2 but the variation among the six countries is marginally less. However, PNG is well ahead of the rest under the SBM suggesting how this particular model heavily favours commercial banks with strong holding of liquid assets.

The overwhelming consensual support for correctly ranking the most efficient and least efficient commercial bank is surprising, suggesting that DEA is fairly successful in ranking the two most extreme performed commercial banks. On the other hand, this favourable finding could well differ when the number of banks increases in the sample.

5.3.3 Q13: Is CIR useful in explaining efficiency scores across banking models?

Table 5.3F: Correlations between CIR and Efficiency: All Frontiers

	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
FIJI	-89.11%	-44.22%	-58.46%	-72.50%	-51.04%	-65.69%
P-Values	**0.000**	**0.008**	**0.000**	**0.000**	**0.002**	**0.000**
PNG	-93.35%	-68.59%	-73.54%	-83.83%	-76.14%	-79.66%
P-Values	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
SAMOA	-81.77%	-85.32%	-74.66%	-78.42%	-84.55%	-67.37%
P-Values	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
CCC	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
DMU	-84.0%	-55.2%	-46.3%	-69.6%	-66.1%	-70.5%
P-Values	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Banks	-86.8%	-58.6%	-47.70%	-81.7%	-75.8%	-78.6%
P-Values	**0.000**	**0.000**	**0.033**	**0.000**	**0.000**	**0.000**

The expectation for this question is that efficiency and the cost income ratio ought to be strong and negatively correlated. In model 1, the results from all three countries strongly support the expectation. Moreover, the CCR model correlates best with the CIR. Finally, the SBM result from Samoa is consistent with the CCR but the strength of the correlation is marginally less, as expected. Therefore, the commercial bank with the least CIR is the most efficient bank and vice versa.

In model 2, the expectation is similar but the correlation is not quite as strong. The only additional point to discuss is that in Samoa, the correlation is marginally strengthened compared with model 1 while Fiji and PNG are declining. That decline is more prominent in Fiji at -44% compared with -70% in PNG. The inconsistency in

Samoan result is driven by SCB with a CIR of 109%, reflecting its entrance in 2003 and operating losses in the first two years.

For model 3, the correlation remains strong. Furthermore, it is declining in Samoa compared with the previous models, and yet Fiji and PNG indicate resurgence in correlations to overtake the results from model 2.

In the context of the three models and CIR, model 1 is expected and confirmed to correlate best with CIR followed by model 2 then model 3. The expectation that the last two models would reverse the result in Fiji and PNG is confirmed, although in Samoa model 2 is highest followed by model 1 and then model 3.

For the CCC, the correlation between CIR and efficiency is strongly negative and highly statistically significant. It is highest at model 1 as expected and declining to its lowest at model 3 and the CCR diminishes at a faster rate compared to the SBM. The correlation from the CCR and CIR is fairly similar at both DMU and average banks level and more varied for the SBM. The coefficients for these correlations are consistent with the finding from the national frontiers, although the strength is marginally weaker.

These findings suggest that the CIR can be a feasible tool for estimating banking efficiency, despite the current unfavourable norm. However, it is worth pointing out that as efficiency constructs expand in the number of input and output variables, CIR ability to measure efficiency accurately weakens. This projection could also be affected when the sample size increases dramatically.

5.3.4 Q14: Does efficiency correlate with ROE?

Table 5.3G: Correlations between ROE and Efficiency: All Frontiers

	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
FIJI	78.23%	50.65%	31.36%	66.30%	53.91%	36.19%
P-Values	**0.000**	**0.000**	**0.002**	**0.001**	0.067	**0.033**
PNG	23.60%	26.86%	8.56%	22.40%	38.94%	4.50%
P-Values	0.227	0.167	0.665	0.140	**0.041**	0.820
SAMOA	79.49%	80.48%	63.35%	82.13%	81.79%	68.35%
P-Values	**0.000**	**0.000**	**0.001**	**0.005**	**0.000**	**0.000**
CCC	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
DMU	66.40%	44.7%	26.7%	56.20%	54.9%	49.5%
P-Values	**0.000**	**0.000**	**0.002**	**0.000**	**0.000**	**0.000**
Banks	70.9%	49.4%	33.3%	67.8%	65.7%	64.8%
P-Values	**0.000**	**0.027**	0.151	**0.001**	**0.002**	**0.002**

WPC dominates the ROE in all three countries and is closely followed by ANZ. Hence, the two Australian banks completely dominate the rest. The average ROE for all commercial banks is highest in PNG at 57% followed by Fiji at 40% and then Samoa at 21%. An interesting feature of the ROE is the dominance of the two Australian based banks WPC and ANZ compared with their local counterparts. Finally, WPC is the more dominant of the two banks at 92% in PNG, 58% in Fiji and 33% in Samoa.

The expected correlation between ROE and efficiency is positive. This is consistently supported by the results in all three countries. However, the correlation between ROE and efficiency is highest from model 1, followed by model 2 and least correlated with model 3, as expected. Furthermore, the strength of the correlation is consistently highest in Samoa, reflecting its highest CAR at 15%, followed by Fiji ahead of PNG. The higher correlation in Fiji compared with PNG is unusual considering the CAR in PNG is 12% compared to the 8% in Fiji. PNG banks also hold more equity than their Fijian counterparts.

In the CCC, the correlations are strongly positive, as evident from both the DMU level and average bank level. Therefore, this question is strongly supported. This finding is also consistent with the resulting correlations between efficiency and ROE from the three national frontiers, although it is stronger than the result from PNG but marginally weaker compared with Fiji and Samoa.

The highest coefficient is in model 1 and highly statistically significant, as expected from both levels. The CCR dominates the SBM from the outset and both declining towards model 3, where the model's construct (input and output variables) is largest. Another obvious trend is the correlation between ROE and efficiency from the CCR, it declines faster (starting at model 1 and moving towards model 3) compared with the SBM model. This is evident in both the DMU and banks average basis, and the level of statistical significance corresponds accordingly.

The implication of this comparable diminishing rate in correlations between the two efficiency measures and ROE confirms the underlying assumptions for both DEA approaches. More precisely, the CCR is one dimensional and focuses on either input efficiency (or output efficiency) whereas the SBM accounts for both simultaneously. Hence, the latter approach is more stable when explaining ROE, which is itself more comparable as it is derived from both inputs (expenses) and output (incomes) levels.

5.3.5 Q15: Does efficiency correlate better with ROA than ROE?

Table 5.3H: Correlations between ROA and Efficiency: All Frontiers

	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
FIJI	85.87%	64.23%	44.58%	82.65%	75.87%	51.79%
P-Values	**0.000**	**0.000**	**0.007**	**0.000**	**0.000**	**0.001**
PNG	74.35%	61.13%	57.29%	66.27%	71.99%	66.61%
P-Values	**0.000**	**0.001**	**0.001**	**0.004**	**0.000**	**0.000**
SAMOA	92.69%	92.13%	76.82%	92.18%	93.78%	79.92%
P-Values	**0.000**	**0.000**	**0.000**	**0.003**	**0.000**	**0.000**
CCC	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
DMU	78.3%	65.0%	45.7%	72.0%	79.4%	70.6%
P-Values	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Banks	81.3%	64.5%	53.5%	83.4%	86.0%	84.1%
P-Values	**0.000**	**0.002**	**0.015**	**0.000**	**0.000**	**0.000**

The two Australian owned commercial banks continue their dominance in ROA, consistent with their dominance in the ROE. There is a slight variation, WPC continues to dominate in Fiji and PNG followed by ANZ but the trend is reversed in Samoa, where ANZ overtakes WPC. Both are well ahead of the two locally owned commercial banks. The average ROA for all commercial banks is highest in PNG at 7% followed by Samoa and Fiji, marginally over 3%. Finally, WPC is the most dominant bank at 9% in PNG and 5% in Samoa. ANZ reverses the dominance in Fiji at 5% compared with 4% for WPC.

The expected correlation between ROA and efficiency is positive. This is consistently supported by the results in all three countries. The correlation between ROA and efficiency is highest from model 1, followed by model 2 and least correlated with model 3, as expected and consistent with the ROE. Furthermore, the strength of the correlation is consistently highest in Samoa, followed by Fiji in models 1 and 2 and PNG dominates Fiji in model 3.

Finally the second component is the expectation that ROA should be better correlated with efficiency than ROE since ROE is further impacted by the differences in capital structure. The results from all three countries consistently support the expectation. This is strengthened by the consistency from all banking models as well as the correlations from the SBM.

The correlation from the CCC is strongly positive and even stronger compared to the ROE, and evident from both the DMU level and average bank level. Therefore, this question is strongly supported. This result is also consistent with the resulting correlations between efficiency and ROA from the three national frontiers, although it is marginally weaker.

The highest coefficient is in model 1 and highly statistically significant, as expected from both levels. The CCR dominance over the SBM is reduced and both declining towards model 3, consistent with the ROE. Again, correlation between ROA and efficiency from the CCR declines faster (starting at model 1 and moving towards model 3) compared with the SBM model but the rate is not quite as quick as in the ROE. This is evident in both the DMU and banks average basis (except in model 2, where the correlation increases) and the level of statistical significance corresponds accordingly. The implication of this comparable diminishing rate in correlations between the two efficiency measures and ROA is consistent with the ROE.

5.3.6 Q16: Could efficiency be explained by the Tripal Ratio?

Table 5.3I: Tripal Ratios in Fiji, Samoa, and PNG

	Fijian Commercial Banks					
	ANZ	WPC	CNB	BOB	HBB	Average
TR 1	1.593	2.137	1.213	1.863	1.479	1.657
TR 2	0.799	0.868	0.805	0.448	0.645	0.713
TR 3	1.079	1.088	1.097	1.065	1.223	1.11
	PNG Commercial Banks					
	BSP	ANZ	WPC	MBK		
TR 1	1.479	2.177	2.377	2.105		2.034
TR 2	0.513	0.643	0.632	0.591		0.595
TR 3	1.066	1.196	1.133	1.657		1.263
	Samoan Commercial Banks					
	ANZ	WPC	NBS	SCB		
TR 1	1.764	1.559	1.183	1.018		1.381
TR 2	0.927	0.953	0.856	0.852		0.897
TR 3	1.238	1.138	1.113	1.083		1.143

Table 5.3J: Correlations between the Tripal Ratios Efficiency: All Frontiers

	CCR 1	SBM 1	CCR 2	SBM 2	CCR 3	SBM 3
FIJI	88.89%	80.45%	54.51%	54.02%	28.12%	25.90%
P-Values	**0.000**	**0.000**	**0.001**	**0.001**	0.102	0.133
PNG	70.49%	72.03%	62.29%	61.20%	49.37%	59.02%
P-Values	**0.000**	**0.011**	**0.000**	**0.001**	**0.008**	**0.001**
SAMOA	89.48%	91.00%	51.53%	43.33%	70.20%	68.18%
P-Values	**0.000**	**0.004**	**0.008**	**0.030**	**0.000**	**0.000**
CCC	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
DMU	85.6%	61.8%	63.6%	80.9%	50.4%	62.20%
P-Values	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Banks	95.8%	63.9%	75.6%	92.2%	49.9%	71.0%
P-Values	**0.000**	**0.002**	**0.000**	**0.000**	**0.025**	**0.000**

The expectation for this question is that efficiency should correlate positively with the TR ratios and TR1 should correlate best with efficiency compared to TR2 and least at TR3 against model 3. The first component of the question is strongly supported in results for all three countries across all three models and further strengthened by the results from the SBM. The implication of this finding is that the Tripal Ratio is consistently mapping the resulting efficiency scores. More precisely, higher TR ratio is strongly associated with higher efficiency. The second component is consistently supported in Fiji and PNG. The correlation between TR1 and model 1 is highest, followed by TR2 and model 2, and least in model 3. On the other hand, the correlation between TR1 and model 1 is also highest in Samoa, followed by TR3 against model 3, and least correlate between TR2 and model 2.

Finally, the conclusion regarding the effectiveness of the Tripal Ratios is very encouraging. This finding is also consistent with Q11, where increasing the number of variables under DEA leads to increasing efficiency scores. The results from Fiji and PNG strongly suggest that the Tripal Ratio can consistently track the efficiency scores under DEA.

Under the CCC, the correlation between the TR ratios and efficiency continues strongly and positively correlated, coming close to perfect correlation (unity) in model 1, particularly for the bank average level. This finding not only confirms the incorporation of this ratio as a worthy checkpoint for resulting efficiency scores from DEA approaches but at this instance (model 1 for the bank average), the impact of self identified efficient DMUs (solely for the purpose of having no other comparable DMUs to compare against) is almost fully nullified.

The increasing correlations in model 3 compared with model 2 is unexpected but not unusual since the former is a measure of the overall banking operational efficiency compared to latter where it is only addressing the intermediation. This finding confirms the structural construction of both models. Model 2 focuses only on the related inputs and output variables that are likely to explain the banking intermediation process, and the model 3 widens this scope to incorporate the non-intermediation components of banking activities such as non-earning assets and such non-loan related opportunities.

The coefficients of the correlation are even stronger compared to the national frontiers, suggesting that the increasing sample size under this CCC not only plays a significant role but also suggesting that this regional common frontier does exist. Finally, this question is strongly supported. Tripal ratios can explain resulting efficiency scores from various DEA approaches and perhaps, validate the efficacy of the efficiency derived by various DEA approaches.

5.4 Efficiency of the two Australian Banks: WPC Group and ANZ Group

The two Australian owned banks (ANZ and WPC) operate in all six countries and in 2005 their combined asset share are above 60% of total assets. Hence, the efficiency of their operations is of particular concern for the stability of these small banking systems. Their operations in Vanuatu are excluded from this analysis as the data was not accessible. National frontiers in Fiji, Samoa, and PNG are used to compare the efficiency of the local banks in each of these jurisdictions. Furthermore, efficiency scores from the CCC frontier where all banks are pooled together provide a secondary platform to assess the efficiency of all commercial banks.

5.4.1 Q17: Is the efficiency of these two banks consistently measured between the National and the CCC Frontiers?

Table 5.4A: Efficiency of the two Australian Banks: All Frontiers

Fiji	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
ANZ	0.81255	0.94028	0.87573	0.74588	0.84114	0.68441
WPC	0.90289	0.97634	0.97264	0.82517	0.92184	0.89304
Local Average	0.76907	0.90591	0.93927	0.64888	0.75518	0.81284
Samoa	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
ANZ	0.97886	0.96439	0.99450	0.96087	0.90176	0.98335
WPC	0.85616	0.91917	0.93992	0.79671	0.81330	0.74482
Local Average	0.84819	0.89781	0.94728	0.75991	0.76800	0.76061
PNG	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
ANZ	0.83311	0.96074	0.96606	0.64356	0.88799	0.86768
WPC	0.89996	0.94617	0.94889	0.76096	0.92440	0.91899
Local Average	0.81586	0.90539	0.92970	0.63777	0.81493	0.85535
CCC	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
AUST	0.71717	0.84732	0.88468	0.51697	0.67240	0.70274
LOCAL	0.59155	0.71798	0.85712	0.38052	0.45226	0.58589
CCC Average	0.64543	0.77293	0.85500	0.44122	0.55799	0.62803

Table 5.4A summarises the efficiency scores from all four frontiers. The average efficiency for both ANZ and WPC are disclosed alongside the average efficiency of

the overall sample. The CCC results summarise the resulting efficiency scores from the CCC frontier and the average scores for the two Australian banks (AUST) throughout the region (Fiji, Samoa, PNG, Solomon and Tonga) alongside the average scores for the remaining banks (LOCAL) in the region.

The results suggest that the two Australian banks average efficiency scores dominate their local counterparts from the three national frontiers in Fiji, Samoa, PNG, and the CCC frontier. Therefore, the consistency of the efficiency from the three national frontiers compared with the CCC frontier is strongly supported. In that, the dominance of the two Australian banks from the three separate national frontiers is maintained in the CCC frontier.

5.4.2 Q 18: Are the efficiency rankings of these two banks consistent between the National and CCC Frontiers?

Table 5.4B: Comparative Efficiency across the National and CCC Frontiers

Fiji	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
ANZ (NAT)	0.81255	0.94028	0.87573	0.74588	0.84114	0.68441
WPC (NAT)	0.90289	0.97634	0.97264	0.82517	0.92184	0.89304
ANZ (CCC)	0.52475	0.70012	0.77942	0.41799	0.48618	0.47373
WPC (CCC)	0.81307	0.88545	0.90314	0.54507	0.66047	0.75327
Ranking*	Yes	Yes	Yes	Yes	Yes	Yes
Samoa	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
ANZ (NAT)	0.97886	0.96439	0.99450	0.96087	0.90176	0.98335
WPC (NAT)	0.85616	0.91917	0.93992	0.79671	0.81330	0.74482
ANZ (CCC)	0.65745	0.83408	0.87395	0.41397	0.67970	0.70215
WPC (CCC)	0.67465	0.85428	0.87426	0.44873	0.61528	0.51042
Ranking*	No	No	No	No	Yes	Yes
PNG	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
ANZ (NAT)	0.83311	0.96074	0.96606	0.64356	0.88799	0.86768
WPC (NAT)	0.89996	0.94617	0.94889	0.76096	0.92440	0.91899
ANZ (CCC)	0.83238	0.81505	0.88555	0.64356	0.66157	0.84806
WPC (CCC)	0.89996	0.83026	0.87879	0.76096	0.68218	0.82023
Ranking	Yes	No	Yes	Yes	Yes	No

The ranking rows account for whether resulting efficiency for both banks is consistently ranked between the national and CCC frontiers. A “Yes” refers to a consistent ranking and “No” is for inconsistency. For instance, in PNG model 1 under the CCR, the resulting ranking is a YES since WPC dominates ANZ in both the national frontier (NAT) and the CCC frontier (CCC).

The main feature of the efficiency scores from the CCC compared to the regional frontiers is the reduction in efficiency scores. This feature is evident in the efficiency scores for both banks in all three countries. However, a notable exception is the average SBM scores for both ANZ and WPC in PNG (similarly, WPC in PNG from the CCR) where the efficiency scores are identical from both frontiers. These unusual observations are more astonishing considering the average scores from the seven year period are identical. As it turns out, the reference sets are identical in both frontiers. In that, the reference sets from the PNG national frontiers continue their dominance to the CCC frontier.

In terms of the efficiency ranking for these two banks from both frontiers, it appears to be fairly consistent, and the SBM ranking is slightly superior to the CCR. In Fiji, the WPC dominates ANZ in all banking models and in both DEA models. This dominance continues consistently from the efficiency scores from the national comparisons into the comparative efficiency scores from the CCC frontier despite the overall reduction in efficiency scores for both banks in the latter comparison. WPC dominance is strongly supported by the Tripal Ratios, as it is more dominant in its TR1, TR2, and TR 3 compared to ANZ.

For Samoa, this strong evidence of consistency in ranking diminishes. The SBM consistently rates ANZ as the more efficient bank in four models but reverses the trend in M1, where the national frontier supports ANZ and the CCC suggests WPC.

As for PNG, it is slightly improving compared with Samoa but not quite as strong as Fiji. The SBM continues to dominate the CCR in ranking all models between the national and CCC frontier compared to the CCR effort in successfully ranking the two banks efficiency scores in models 1 and 3. The Tripal Ratios favour WPC in model 1 and ANZ in the remaining models, and yet only the CCR national frontier (also the SBM model 1 from both frontiers) ranks the efficiency of the two banks accordingly.

The superior accuracy of ranking of the efficiency of the two banks in Fiji compared with Samoa and PNG may well be attributed to the increasing sample size in Fiji where it has 35 DMUs compared with the relative smaller size in PNG at 28 and 25 in Samoa.

5.5 Chapter Summary: Binding the effectiveness of the Explanatory Variables and the Validating Procedures

This section incorporates and summarises the role of the explanatory variables and validating procedures (or checkpoint variables). In this context, the three main components (efficiency measurements, explaining the variations in resulting efficiency scores, and validating efficiency results) of the data analysis are combined to provide a meaningful summation for the chapter without the need to repeat the key findings and discussions and yet, leaving the overall conclusions to be presented in the next chapter. This binding effort is based on important question of what can we conclude regarding the distinction of the efficient commercial banks compared with their inefficient counterparts.

Efficient and Inefficient Banks

This central question gives rise to this final analysis: a sector analysis to distinguish efficient commercial banks from its' inefficient counterparts. In that, the two groups are simply called Efficient and Inefficient. The first group is made up of the 10 most technically efficient banks and the latter, the remaining 10 inefficient banks from the Common Frontiers. Eight banks (Five are from WPC, two from ANZ (PNG and Samoa) and MBK)) from the efficient groups remain efficient across all three banking models and eight inefficient banks stay inefficient throughout. This is an 80% ranking consistency across all banking models and two DEA approaches.

Table 5.5A: Efficient and Inefficient Banks: Comparable Scores

CCC	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
Efficient	0.78510	0.86776	0.93283	0.57682	0.69372	0.80159
Inefficient	0.50576	0.67809	0.77716	0.36561	0.42226	0.45446
Average	0.64543	0.77293	0.85500	0.44122	0.55799	0.62803

Table 5.5B: Efficient and Inefficient Banks: Comparable Explanatory and Checkpoint Variables

CCR 1	AGR	LGR	GL/DAL	PDD/GL	BDD/PDD	CIR	ROE	ROA	TR 1
Efficient	0.1323	0.1691	0.6803	0.0413	0.2290	0.4051	0.5353	0.0657	1.9738
Inefficient	0.1913	0.2050	0.7818	0.0665	0.2377	0.7294	0.2426	0.0284	1.3301
SBM 1									
Efficient	0.1398	0.1798	0.6814	0.0465	0.1754	0.4339	0.5257	0.0643	1.9285
Inefficient	0.1838	0.1943	0.7807	0.0613	0.2913	0.7006	0.2522	0.0299	1.3753
CCR 2	AGR	LGR	GL/DAL	PDD/GL	BDD/PDD	CIR	ROE	ROA	TR 2
Efficient	0.1439	0.1859	0.8060	0.0497	0.1913	0.4493	0.5127	0.0662	0.8353
Inefficient	0.1796	0.1882	0.6561	0.0580	0.2754	0.6852	0.2652	0.0280	0.6549
SBM 2									
Efficient	0.1375	0.1778	0.7507	0.0454	0.1944	0.4080	0.5307	0.0684	0.8137
Inefficient	0.1861	0.1963	0.7114	0.0623	0.2723	0.7265	0.2472	0.0258	0.6765
CCR 3	**AGR**	**LGR**	**GL/DAL**	**PDD/GL**	**BDD/PDD**	CIR	**ROE**	**ROA**	**TR 3**
Efficient	0.1503	0.1782	0.7598	0.0478	0.2266	0.4471	0.5292	0.0634	1.2125
Inefficient	0.1733	0.1959	0.7023	0.0599	0.2401	0.6874	0.2487	0.0307	1.0520
SBM 3									
Efficient	0.1333	0.1591	0.6993	0.0439	0.1956	0.4220	0.5297	0.0672	1.2284
Inefficient	0.1903	0.2150	0.7628	0.0638	0.2712	0.7125	0.2481	0.0270	1.0361

In model 1, the explanatory and checkpoint variables for the efficient banks dominate their inefficient counterparts. Efficient banks have marginally less annual growth in assets, less growth in loans, and less intermediation under both DEA models. Consequently, efficient banks continue to be supported by less loan provisions and less loan losses. CIR is significantly less for efficient banks, where the gap between the two groups is most evident at about 30% less for efficient banks in both the CCR and the SBM. ROE and ROA further validates this distinction as both measures are much stronger for the efficient banks. Finally, the TR 1 for efficient banks is significantly ahead by over 40% (CCR is 48% and 44% for the SBM) compared with their inefficient counterparts.

Model 2 focuses on the intermediation process and the trends are fairly similar to model 1. Efficient banks continue to have less annual growth in assets and less growth in loans but both average growths are marginally higher under the CCR and marginally unchanged for the SBM compared with model 1. The degree of intermediation for efficient banks is significantly higher in both the CCR and the

SBM, reversing the trend from model 1. Efficient banks continue to be supported by less loan provisions due to less loan losses. Moreover, average loan provisions increases from 4% in model 1 to 5% under the CCR and again, remain unchanged for the SBM. Furthermore, loan losses widen between the two groups to about 10% under the CCR compared with a mere 1% in model 1.This trend is maintained by the SBM in this model 2 and earlier in model 1.

The checkpoint variables continue to be dominated by the efficient groups, although it is marginally weakened, a contrast to the increasing dominance of the explanatory variables. CIR continues to be significantly less for efficient banks. ROE and ROA further validates this distinction as both measures are much stronger for the efficient banks. Finally, TR 2 of the efficient banks remains dominant but the gap is reduced to about 20% against their inefficient counterparts.

Contrary to model 2, this model 3 main objective is to measure the overall production process. Efficient banks continue the trend in model 1 and 2 as the annual growth in assets is less than their inefficient counterparts, and growth in loan is marginally less in model 3 compared with model 2. The implications of this result perhaps, signalling the danger in unsustainable growth, one of the two key components in prudential supervisions.

The GL/DAL ratio is not conclusive in regards to the exact composition of the loan portfolio: the CCR suggest that this ratio is higher for the efficient group but the SBM reverses the trend in model 3. This conflicting evidence is attributed to the emerging impact of the liquidity requirements, previously explained in section 5.1.5 and presented next in Table 5.5C.

Loan provisions for the efficient group favours less loan provisions but the gap between the two groups is marginally unchanged across the two DEA approaches. Loan losses continue to favour the efficient group but the gap is narrower under the CCR and unchanged under the SBM compared with model 2. Therefore, these findings support the methodology construct with regards to the fundamental objectives of the various banking models.

CIR continues to be significantly less for efficient banks, ROE and ROA further validates this trend and are much stronger for the efficient group. Finally, TR 3 for efficient banks remains dominant at about the same level of 20%, as in model 2 ahead of their inefficient counterparts.

Liquidity Requirements and Efficiency

Table 5.5C summarises the average efficiency scores for commercial banks under each group. The "High" group reflects the average technical efficiency scores for commercial banks with higher liquid assets, hence the "Low" group accounts for banks with lower holding of liquid assets. The discussion covers both LAR 1 and LAR 2 in model 1, and only LAR 2 in the models 2 and 3.

Table 5.5C: LAR 1, LAR 2, and Efficiency from the Common Frontiers

LAR 1	CCR 1	CCR 2	CCR 3	SBM 1	SBM 2	SBM 3
High*	0.57514	0.76303	0.84711	0.37877	0.55016	0.57274
Low	0.71572	0.78282	0.86289	0.50366	0.56582	0.68332
LAR 2						
High**	0.68678	0.71358	0.81543	0.48525	0.50672	0.62793
Low	0.60408	0.83228	0.89457	0.39718	0.60925	0.62813

*Consisting of all three banks in Solomon, all three banks from Tonga, the two small banks from Samoa (NBS and SCB), HBB in Fiji, and NBV. ** Including all four banks from PNG, ANZ and NBSI from Solomon, BOB and HBB from Fiji, MBF in Tonga, and NBV.

The result strongly confirms that commercial banks with higher LAR 1 (notes and coins and balance with central bank) are almost associated with lower resulting efficiency scores. The difference between the two groups is most evident in model 1, the gap is widest compared to the rest of the banking models and suggests that the volume of LAR 1 holding not only impacts upon bank efficiency but on profitability as well.

LAR 2 reverses the trend from LAR 1 but efficiency is not purely determined by the holding of liquid assets. Model 1 conclusively suggests that higher LAR 2 leads to higher efficiency and supported by both CCR and SBM. However, the difference between the two groups is not as wide as in LAR 1.

In model 2, this result is reversed where higher LAR 2 is associated with lower efficiency scores. This is not surprising considering model 2 addresses the degree of banking intermediation focussing on the volume of loans issued from deposits. Therefore, higher LAR 2 simply reflects that relatively fewer loans are issued while holding more liquid assets. Furthermore, the gap between the efficiency of the two groups is widest compared to models 1 and 3.

However, in model 3 the two LAR 2 groups are not conclusively signalling efficiency. CCR 3 suggests that banks with lower LAR 2 are more efficient but the SBM models are unclear. This is not surprising since SRD impacts upon DAL input variable and MLAR impacts upon OEA output variable and SBM 3 confirms that both variables are highly significantly and most influential in determining bank efficiency. DAL is by far the strongest source of input excess and OEA is the most dominant source of output shortfall, previously discussed in section 5.1.5. This conflicting observation is perhaps the strongest evidence in unveiling the full impact of liquidity requirements in bank efficiency.

In that context, high liquidity requirements naturally force commercial banks to be more stringent, as reflected by the resulting efficiency from model 1, engaging marginally less degree of intermediation as reflected by lower efficiency levels in model 2. The overall efficiency in model 3 suggests stronger resilience toward adverse or changing economic conditions. During favourable economic environment, banks with higher liquid assets may not be most profitable but given the opposite adverse conditions, they are more resilient and outperform their counterparts with less liquid assets.

In conclusion, this resilience for unexpected and adverse economic conditions is the core fundamental for banking supervision and yet liquidity requirements continue to be the most under rated and least emphasised prudential tool by global practitioners.

Chapter 6: Conclusion

This concluding chapter highlights the key empirical findings and provides a cohesive binding for all previous chapters.

6.1 Research Review

The introduction in chapter 1 provides the essential guidelines in directing this research to incorporate the local settings and economic environment of the commercial banks in the Pacific region. In that context, the literature discussion in chapter 2 is predominant based on practical relevance and applicability to the region. The greater emphasis on local prudential requirements in chapter 3 significantly assists in facilitating the methodology decisions in chapter 4 and how efficiency measurements ought to be constructed, and therefore better equipped to analyse the relative efficiency of the commercial banks in the region.

The extensive scope of efficiency measurement procedures such as the adoption of three banking models, multiple DEA approaches, and four efficiency frontiers provide greater opportunities to better understand and explain the variations among commercial banks' efficiency and inefficiency sources. These procedures further strengthen the research's triangulation synergies, hence, the discussion of empirical findings are enhanced.

This research attempts to provide some empirical evidence regarding the impact of prudential requirements in the industry. In that, SRD, MLAR, asset quality, and CAR in banking efficiency in both the intermediation process and the overall banking production process are investigated on an individual basis. While a micro oriented approach in itself is a progress, the next stage is to investigate their combined effect in bank efficiency since we cannot realistically assume that individual banking policy affects banking operation in isolation without practical interaction from other prudential requirements or policies. In that, better combinations of banking policies become more of a realistic goal to consider once the combined effect of each possible combination is established.

The overall implications of this thesis are to provide a logical explanation towards the fundamental causes and potential determinants of the commercial banks' efficiency in these six countries. In that effort, we hope to make a small contribution towards unveiling the opaque black box phenomenon famously suggested by Berger & Mester (1997).

6.2 Sources of Efficiency and Inefficiency in the Region

This section summarises the potential determinants of efficiency among the commercial banks in the region. This discussion is based on the series of explanatory variables which are different from the other series of validating variables, both defined in chapter 4.

In general the commercial banks' average efficiency is improving over time. This increasing efficiency is driven by increasing intermediation and favourable increasing growth from the general economy since GDP is positively related to bank efficiency. This finding is economically sound and practically relevant. If economic conditions are favourable, as in higher GDP, banks are more likely to intermediate more and experience less credit defaults. On the other hand, the opposite is expected and is normally observed.

However, high growth in assets and loans are not directly consistent with bank efficiency. This implication is consistent with increasing assets and loans due to merging or the entrance of new banks. In that context, bank acquisition through merging is identified to be associated with short term decline in efficiency, while the entrance of a new bank normally associates with longer persistence of diminishing efficiency. Consequently, an increase in banking assets is negatively related to bank efficiency.

Asset quality is negatively related to efficiency. In that context, loan provision provides the first line of defence against loan losses. If this line of defence is worn down then deteriorating asset quality could cause further damages. While higher loan provision slows down bank intermediation, inadequate provisions could trigger severe consequences as reflected by its inverse relationship with inefficiency.

Higher level of CAR is marginally inversely related to efficiency. In that, banks with higher CAR beyond the prescribed level are most likely to be operating inefficiently and suggesting more room for intermediation. A consequence of the CAR framework is the variation between technical and scale efficiency. The correlation between the two measures of efficiency is positive, fairly strong, and statistically significant. However, after plotting the two regional average ratios across models 2 and 3, the picture tells a different story. Four out of six countries suggest that the two efficiency measures are consistent, Fiji and Vanuatu are inconsistent. PNG is the least scale efficient while technically more efficient. Vanuatu reverses the trend by being the most scale efficient and least technically efficient. However, the Vanuatu result is based only on the National Bank of Vanuatu.

In relation to liquidity requirements, LAR 1 is negatively related with efficiency but LAR 2 is positive. The finding from the SBM strongly suggests that liquidity requirements are the most significant determinants of bank efficiency. This is unexpected as we are naturally assuming that intermediation through successfully issuing loans is the primary source of efficiency in banking. In this dataset, liquidity requirements play the most significant role in addressing bank efficiency, which should favour high liquidity requirements, and formally prescribed liquidity standards should be preferred over informal.

This proposal is more practical for small economies for a number of reasons: firstly, the small number of banks within each country reduces the potential sources of liquidity through the interbank market. Secondly, the commercial banks are not large enough to warrant successful access to foreign liquidity markets and sources. Finally, the absence of an active secondary market or participants poses more challenges for local banks to quickly convert illiquid assets into liquid assets when liquidity need arises.

6.3 Effectiveness of DEA application in small economies.

Following the decision from chapter 2, DEA is the most relevant approach to measure the efficiency of the commercial banks in this study. This section reviews the effectiveness of the DEA approach. In that context, there are two avenues in which this assessment is conducted: firstly, the consistency of the DEA in ranking commercial banks across the three banking models; and the effectiveness of the validation procedures in explaining bank efficiency variations.

In relation to the first assessment, DEA generally ranks commercial banks fairly consistently across the various banking models. More precisely, efficient banks remain efficient across the three banking models and the most and least efficient banks are consistently identified. However, the SBM approach, originally used as a comparable measure against the widely practised CCR, turns out to be superior in ranking banks than the CCR.

The second assessment revisits an interesting question by Mr. Sturrock in responding to Farrell (1957) presentation of his landmark article: “To call all these freakishly good results 100% efficient would result in hanging the carrot too high and the donkey would be discouraged”. This humorous and yet stimulating comment emphasises the need to question what we mean by efficiency. The spirit and intention of this quote reinforces the practical relevance of the validating procedures.

The most common feature of the correlations between the variables used for this procedure is that, the resulting coefficients between the validating variables and bank efficiency are consistently stronger (and statistically more significant) than the correlations between explanatory variables and bank efficiency.

The Cost to Income ratio (CIR) is generally practiced by banking practitioners in the region and this ratio (commonly referred to as an efficiency ratio) is included in the financial statements. Efficiency and CIR are negatively correlated, the coefficients being very strong, and are strongly statistically significant in all banking models. This empirical evidence seems to question the common norms (of disregarding the use of this simple ratio) in the literature, at least in the banking context. CIR consistently mimics bank efficiency ratings despite the choice of DEA models used or the combination of inputs and outputs across the three banking models.

Traditional profitability measures continue to support a consistent relationship with bank efficiency. The correlation for both ROE and ROA with bank efficiency is strongly positive and statistically significant. ROA dominates ROE regarding the strength of the correlations and the diminishing rate of the correlation coefficients is slower for ROA than ROE as the banking models increase from model 1 to model 3.

The Tripal Ratio (TR) has served the validation procedure very well. The correlation between bank efficiency and TR is positive and the coefficients are the strongest for all variables and are statistically significant for all banking models. In conclusion, this ratio is proven the most effective in validating resulting efficiency scores. While these strong results confirm its role under the DEA approaches, this simple tool should continue to remain effective in the other efficiency approaches including both parametric and non parametric approaches.

On the other hand, this ratio may not function effectively if all inputs or outputs are not measured similarly. For instance, if one input is measured in dollar terms and the next input is measured in speed or miles per hour then this simple ratio becomes problematic. However, if both inputs are measured in dollar terms and both outputs in speed then this simple ratio remains useful.

The overall conclusion to be drawn regarding the use of the DEA approaches in measuring the efficiency of the commercial banks in these small economies is proven effective and therefore, strongly warranted.

6.4 Contribution to understanding banks' efficiency in the Pacific Region

The structure for this section follows the three main applications of bank efficiency studies according to Berger & Humphrey (1997) including informing government policies, address research issues, and improving managerial performance.

- Informing government policies

Firstly, prudential requirements in the region remain fairly conservatively constructed and yet continue to serve the needs of banking in the region. Therefore, higher liquidity requirements and a stronger CAR framework should continue to better serve the region's banking systems. The former is more effective than the latter but together they are even better.

Secondly, the overall stability of these banking systems is strengthened by the dominant efficiency of the two Australian owned banks: Westpac and ANZ Group which have extensive operations in the region. However, the third largest commercial bank, the PNG based Bank of South Pacific may need to improve its operational efficiency considering its ongoing expansion.

Finally, macroeconomic activity does have a significant role to play in affecting banking efficiency. In that, we need to explore which type of prudential requirements that is more appropriate to use under certain economic conditions. Furthermore, there is a greater need to better understand the likely interactions between prudential requirements, economic activities, and the resulting stability of the banking systems considering the critical role commercial banks undertake in delivering monetary policy and facilitating economic growth.

- Banking research issues

Firstly, the complexity of the banking industry may well need multiple banking models to assist the measurement, explanation, and comparison of banking efficiency. For example, banking model 1 suggests that interest margin is a primary force for efficiency and profitability subject only to containing non interest income. Model 2 concludes that CAR is an ineffective tool for containing banking intermediation and asset quality. Model 3 strongly suggests that liquidity requirements are the dominant source of inefficiency despite the overemphasis on and common perceptions held about the loan portfolio.

Secondly, resulting efficiency from banking firms will continue to be clouded and questioned by both practitioners and banking supervisors unless more efforts are dedicated to validate resulting efficiency scores. As such, variation in efficiency measurements (or choice of constructs, input, and output combinations) and the variation in the availability, and consistency of reported banking data will continue to impact significant progress towards consensus and better understanding of the global determinants of bank efficiency, which is further confounded by the evolving nature of banking operations.

- Improving managerial performance

Efficient commercial banks are most likely to be associated with sustainable growth in loans, stronger intermediation, adequate loan provisions, and better asset quality. Equity can facilitate more intermediation regardless of the CAR framework. Liquid assets have a stronger impact in bank efficiency well beyond liquidity risk, perhaps an anchor for bank stability, at least in smaller economies.

Finally, scale inefficiency is significantly larger than the level of scale inefficiency in the literature. This is the case in PNG, Samoa, Tonga, and Solomon. Fiji and Vanuatu are significantly more scale efficient. This unusual finding could well be associated with smaller economies where the deliverance of banking services are fairly limited, although demand for banking services could also be a factor.

6.5 Research limitations and implications

The most dominant limitation in this study is the small number of commercial banks in these small economies. This feature is a primary consideration in the decision making process and dictates the scope and chosen literature in chapter 2, dominates the structural and practical relevance of chapter 3, and continues through the methodology decisions in chapter four.

A consequence of this small sample size, it allows a pseudo forensic approach to bank efficiency. This is evident from the use of multiple banking models, multiple DEA models, range of explanatory variables, increasing number of validation procedures. The impact of prudential requirements in bank efficiency, implications of macro economic variables in bank efficiency, detailed exploration of the implications of large and foreign banks' impact on the stability of these small economies. Finally, a proposed sectoral analysis is used as a comparable tool of efficiency analysis without relying on the traditional statistical correlations and regressions. Therefore, the consequence of this research limitation has given rise to pursuing far more interesting avenues than could otherwise have been possible.

Secondly, the disclosure framework across these countries is varied, and in some cases poses a significant challenge. An example of this challenge is the unavailability of some of the basic financial statements in Tonga and Vanuatu. For future researchers, the best avenue to consider is through the AFSPC (section 3.4.1). This institution has enormous potential, and its extensive regional membership base could help accessing relevant and more useful banking data.

Thirdly, even when financial statements are accessible, efforts to standardise financial data in a meaningful manner before data analysis continue to be a concern. For instance, while asset quality is explicitly prescribed by the local prudential supervisor, the disclosure of such data in some cases remains inconsistent and meaningless.

6.6 Future research challenges and opportunities

The main challenges for researchers in banking efficiency continue to be dominated by the lack of consensus on how the efficiency of banking institutions ought to be measured. This is further complicated by the existing disagreements on what banks actually do, and this problem is stretched even more when cross country comparison is pursued, and applicable to both developed and developing economies.

On the other hand, these challenges continue to present a wealth of opportunities for researchers. For small economies, research opportunities are even greater. This is attributed to the small number of banking firms, enabling a better understanding of what banks actually do, the regulatory frameworks and financial environment they are subjected to. For larger economies, the evolving nature of banking institutions and the increasing scope of universal banking further complicate research opportunities with regards to the fundamental assumptions and measurements of bank efficiency.

Finally, the quotation by Neibuhr in the opening chapter echoes even more vividly…*the serenity to accept the things I cannot change, courage to change the things I can, and the wisdom to know the difference*.

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