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Developing foreign bank efficiency models for DEA grounded in finance theory

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Abstract

We develop foreign bank technical, cost and profit efficiency models for particular application with data envelopment analysis (DEA). Key motivations for the paper are (a) the often-observed practice of choosing inputs and outputs where the selection process is poorly explained and linkages to theory are unclear, and (b) foreign bank productivity analysis, which has been neglected in DEA banking literature. The main aim is to demonstrate a process grounded in finance and banking theories for developing bank efficiency models, which can bring comparability and direction to empirical productivity studies. We expect this paper to foster empirical bank productivity studies.

Keywords: DEA; Efficiency models; Foreign bank productivity

1. Introduction

This study develops foreign bank efficiency models for particular application in data envelopment analysis (DEA). The main motivations for the study are (a) the often-observed practice of choosing inputs and outputs where the selection process is poorly explained and linkages to theory are unclear, and (b) foreign bank productivity analysis, which has been neglected in DEA banking literature.

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While a choice of variables can be justified in its own setting, it makes a direct comparison between findings from different studies difficult at best. Thus, our principal aim is to develop foreign bank efficiency models grounded in finance and banking theories, which can bring comparability and direction to empirical productivity studies. Specifically, we develop technical, cost and profit efficiency models.

Efficient and profitable banks are vital to successful economic management. In recognition of this principle, researchers continue to spend considerable time studying and measuring bank productivity. While this field was dominated by econometric modelling in its earlier days, the last 15 years have witnessed the emergence of a non-parametric technique known as DEA. DEA is a linear programming technique that computes a comparative ratio of multiple outputs to multiple inputs for each decision-making unit (DMU), which is reported as the relative efficiency score. The efficiency score is usually expressed as a number between 0% and 100%. A DMU with a score less than 100% is deemed inefficient relative to others.

Earlier applications of DEA measured the technical efficiency of DMUs rather than their allocative efficiency. In the context of DEA, technical efficiency investigates how well the production process converts inputs into outputs, whereas allocative efficiency is defined as the effective choice of inputs vis. à vis. prices with the objective of minimising production costs, that is, selection of an effective production plan. Thus, allocative efficiency can be residually calculated as the ratio of cost efficiency to technical efficiency, where cost efficiency is the ratio of the minimum production cost observed in the sample to the actual production cost of the DMU investigated. It is also feasible to measure profit efficiency using DEA, where both cost and revenue efficiencies are incorporated in the calculation simultaneously.

An advantage of DEA is that there is no preconceived structure imposed on the data in determining the efficient units (see [1,2]). That is, DEA does not assume a particular production technology or correspondence. The importance of this feature of DEA is that a bank's efficiency can be assessed based on other observed performance. As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient, rather than trying to associate a DMU's performance with statistical averages that may not be applicable to that DMU. Furthermore, the standard DEA output reports the various potential improvements in input usage or output generation for the inefficient DMU. Hence, DEA can be a valuable benchmarking tool. The reader is referred to Cooper et al. [3] for a comprehensive technical exposition of DEA and to Avkiran [4] for a hands-on application of the technique in the service sector including the banking and finance industries. An article by Dyson et al. [5] provides a good account of pitfalls and protocols in DEA.

The study begins by briefly outlining banking in the theory of finance and highlighting the links between shareholder wealth maximisation and bank risk–return frameworks (Sections 2.1 and 2.2). Section 3 acknowledges the key measures of bank performance analysis in use. The study then reviews the main bank behaviour models used to classify variables into inputs and outputs of efficiency analysis (Section 4). This is followed by a focus on foreign bank motivations behind setting up operations with a view to uncovering new variables that can fine-tune the more general bank efficiency models (Section 5). Section 6 outlines the proposed efficiency models for foreign banks and the study concludes in Section 7.

2. Developing foreign bank efficiency models grounded in theory

2.1. Theory of finance and bank equity value

2.1.1. Banking in the theory of finance

Theory of finance often cites the primary objective of corporate decision-making as maximising the market value of the firm to its shareholders. Furthermore, the concept of maximising the equity value is not confined to the academe. It is almost religiously quoted by chairpersons and managing directors in annual reports. It is essentially an acknowledgment of management's accountability to shareholders, where agency costs can be minimised, and scarce resources allocated effectively and efficiently. In its widest sense, a firm's performance objective can be interpreted as maximising the value of its shareholders' investments at sustainable levels; thus, in the long term, the key measure of overall bank performance must be the market price of its common shares.

Although the assumption of perfect markets is the starting premise for theory of finance, this is often relaxed to various degrees. For instance, perfect capital markets would imply equal borrowing and lending rates, thus removing the key commercial reason for the existence of banks. Given that banks abound, we can thus conclude that capital markets are not perfect. While this may appear to cast a doubt on the usefulness of share prices as indicators of overall bank performance, we need not be overly concerned as long as the discount rate is an appropriate representation of the risk and timing of expected cash flows.

Fama [6] investigates commercial banking in the light of theory of finance. According to Fama, banks serve two key functions, namely, (a) a transaction function, i.e. an accounting system of exchange for transferring wealth, and (b) a portfolio function, i.e. collecting deposits, making loans, and purchasing securities. When banking is practised in a competitive environment, portfolio activities need not be externally regulated because they are similar to the pure financing decisions addressed by Modigliani and Miller's [7] theorem in Proposition I, i.e. bank financing neither expands nor contracts the investment opportunity set. An extension of the argument that the portfolio function is less important to bank management in a competitive environment highlights the potential availability of perfect substitutes for products and services. Hence, the conclusion of Fama's argument is that banks should focus their efforts on earning fees rather than managing their portfolio structures, which is of no consequence to investors. Yet, in practice, banks actively manage their assets and liabilities because they want to take advantage of market imperfections and enhance the efficiency of the transaction function.

2.1.2. Key variables and activities in maximising equity value in financial institutions

Hempel and Yawitz [8] identify the key variables that determine cash benefits as gross receipts from assets (i.e. interest income and non-interest income from loans), cost of liabilities (i.e. interest expense on deposits), overhead costs (i.e. non-interest expense), taxes, and an appropriate risk premium to be added onto the risk-free interest rate; managerial decisions are expected to be examined for the different ways that they may interact with these key variables. They also produce four categories of key activities influencing the equity value, namely, spread management, control of overhead, liquidity management, and capital management. These categories are briefly explained next.

Spread management refers to management of the difference between gross revenues (interest income plus non-interest income) and interest expenses. Although it is possible to realise high spreads in the short run by mixing short-term liabilities with long-term assets, a more desirable state of affairs is to sustain a high positive spread over time within prudent guidelines. Of course, no spread management can be complete without controlling non-interest expenses.

Control of overhead costs or non-interest expenses deals with the ability of the bank to hold down such expenses while maintaining a high spread. High gross spreads may not always translate into high net spreads if investment decisions are not closely scrutinised for their impact on non-interest expenses.

Liquidity management has traditionally involved the presence of short-term assets that can be quickly converted to cash to meet unexpected deposit withdrawals or funding needs, and liquidity requirements of the country's central bank. The bank management will normally attempt to hold enough short-term assets without unnecessarily lowering their profit performance due to the generally lower yields associated with such assets. However, today's liquidity management increasingly involves borrowing from interbank markets serviced by wholesale banking, and securitisation of assets [9].

Capital management refers to balancing the level of capital in such a manner that growth of assets and liabilities is sustainable without eroding public confidence or profitability.

2.1.3. *Another framework explaining bank equity value*

Sinkey [10] arrives at a similar conceptual framework (see Fig. 1). The bank's primary objective of maximising shareholders' wealth is depicted as being shaped by owners' preferences, management's attitudes and decisions, and society; also listed are six policy strategies to achieve that objective. Management's attitudes and decisions, the regulatory and economic environment, and the objective of maximising equity value in turn, influence these policies. The success of these policy strategies depends on the riskiness of a bank's balance sheet, that is, the nature of assets and the concentration of loan portfolios.

The first four policies listed in Fig. 1 have already been outlined as part of Hempel and Yawitz' [8] framework. The term *control of burden* places overhead costs in the context of non-interest income (i.e. fee income), where *burden* is defined as the difference between non-interest income and non-interest expenses. Tax management refers to reducing taxable income, whereas management of off-balance sheet activities (such as letters of credit, lines of credit, and loan commitments) serves to increase fee income and thus, reduce the burden.[1]

As indicated earlier, the market price of common shares can be regarded as a measure of overall bank performance. Unfortunately, such an aggregate measure does not provide feedback on specific managerial decisions, be it operational or strategic. Nevertheless, the discussion up to this point has already enabled us to identify some key variables that influence bank shareholders' wealth, namely, interest income, non-interest income, interest expense, and non-interest expense. Two more conceptual frameworks for evaluating bank performance are reviewed next in an effort to enrich the discussion. As explained later, these conceptual frameworks are more similar than dissimilar.

[1]Burden is normally a negative number since non-interest expenses tend to exceed non-interest income, although this gap has been narrowing over the years.

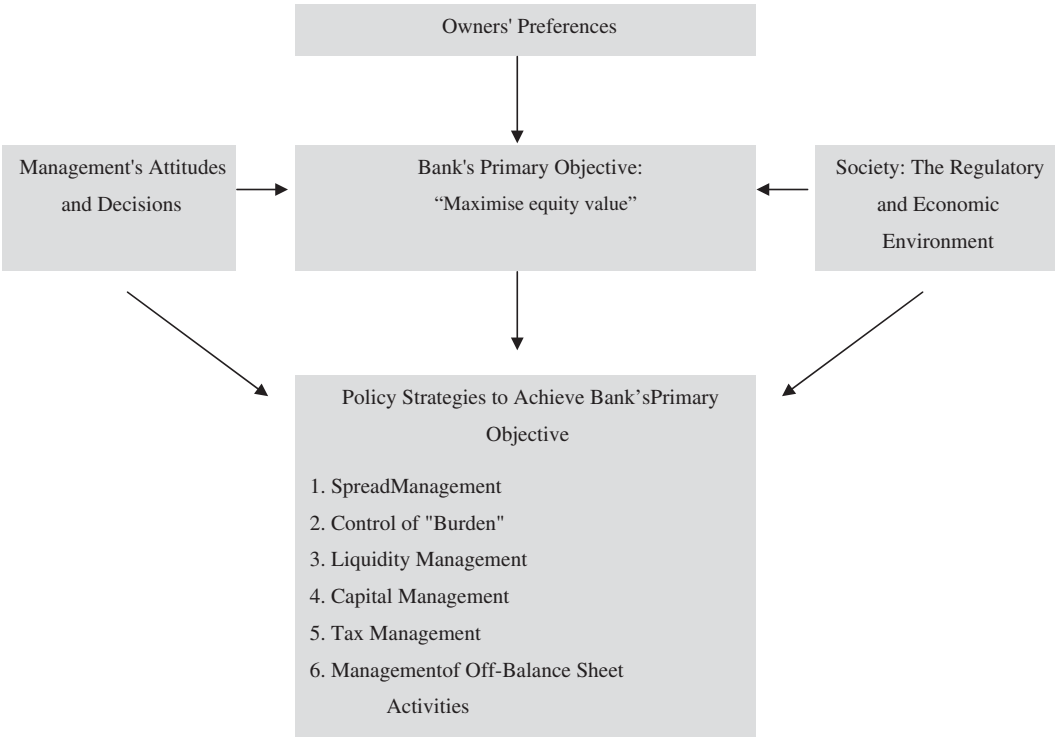

Fig. 1. Policies to maximise bank equity value (adapted from [10, p. 70]).

2.2. *Converging bank risk–return frameworks with wealth maximisation*

2.2.1. *A risk–return framework with controllable and non-controllable factors*

Sinkey [11] decomposes overall bank performance into risk and return (see Fig. 2). Return is measured by the financial ratio return on equity (ROE), which is defined as net income divided by average equity, and risk is measured by variability of ROE.[2]

ROE is decomposed into equity multiplier (EM = ratio of average assets to average equity), and return on assets (ROA = ratio of net income to average assets); EM, measuring capitalisation, can also be interpreted as a measure of a bank's leverage or potential risk exposure. ROA, which is a measure of profitability, is further decomposed into controllable factors, and non-controllable environmental factors. Examples of non-controllable factors are inflation, regulatory constraints, and availability of close substitutes, that is, supply and demand conditions. Examples of controllable factors are depicted in Fig. 2. This risk–return framework is consistent with the value-maximisation framework (see Fig. 1); more specifically, controllable factors business mix, income production, and loan quality are part of spread management, liquidity management, and capital management.

[2]Variability of ROE can be computed through *variance* or *standard deviation* of ROE. Variability of ROE can, in turn, be traced to different types of risks of doing business such as portfolio risk, regulatory risk, technological risk, and so on [11].

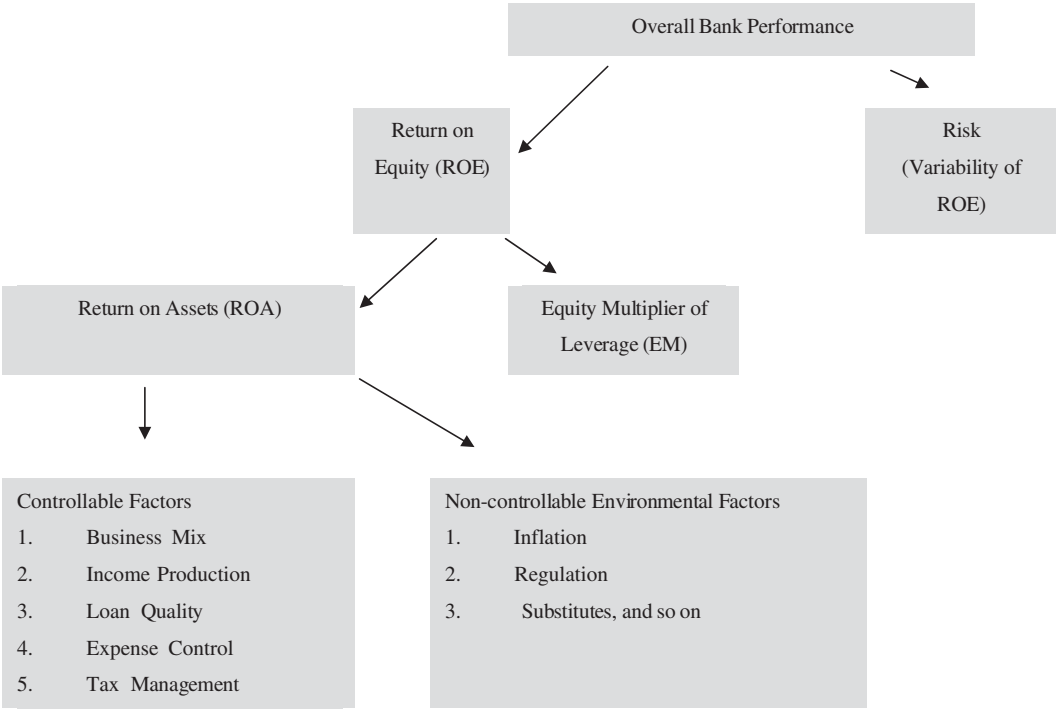

Fig. 2. A risk–return bank performance framework with controllable and non-controllable factors (adapted from [11, p. 130]).

2.2.2. *A risk–return framework showing key areas of managerial decision making*

Fraser and Fraser [12] identify the two principal dimensions of bank performance as profitability and risk. As part of the overview, they state, "The bank's principal goal is to maximise the value of the organisation to its shareholders" [12, p. 29]. Thus, the principle of maximising equity value, which applies to other types of business as well, is re-visited.[3]

In practice, all kinds of managerial decisions influence profitability and risk (see Fig. 3 for some key examples). The management would be responsible for striking that fine balance between return and risk. In the remainder of their discussion on dimensions of bank performance, Fraser and Fraser [12] examine financial statements in an effort to analyse profitability and risk; main ratios reviewed are ROE, ROA, leverage multiplier (also known as EM), interest sensitivity ratios, liquidity ratios, and the equity capital ratio (the reciprocal of EM).

Managerial decisions that raise returns while risk levels remain the same, or reduce risk levels while returns remain the same, would increase profitability and wealth of the shareholders. However, the risk–return trade-off suggests that the above are unlikely to be maintained in equilibrium, and that management would be occupied with balancing returns against risk in reaching desired outcomes. This suggests that bank performance analysis should measure the profitability and risk dimensions.

[3]However, if the bank does not have publicly traded shares, then the management will have to focus on measures of profitability and risk.

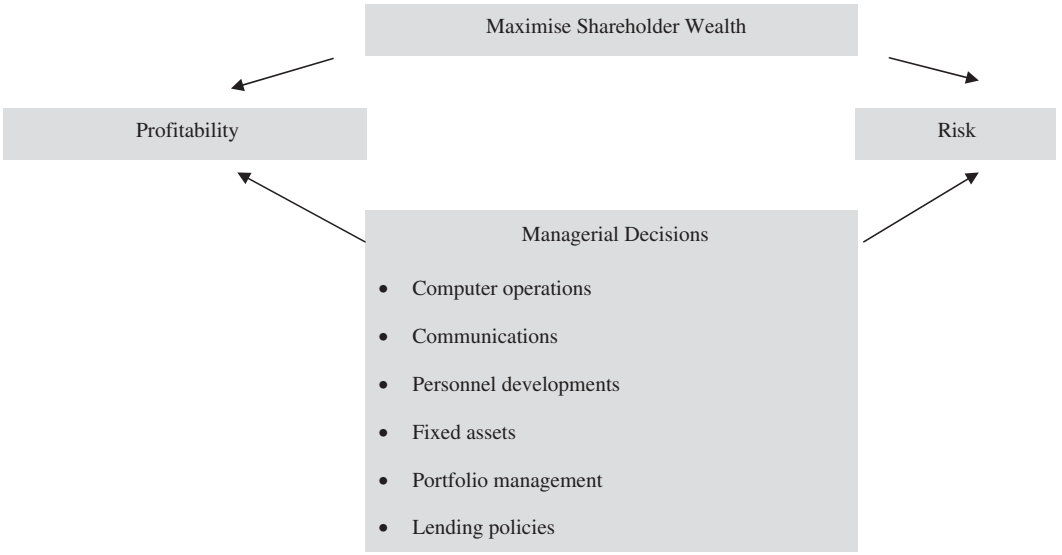

Fig. 3. A risk–return bank performance framework with key areas of managerial decision making (adapted from [12, p. 32]).

2.2.3. *Finding common ground among the two risk–return frameworks*

In summary, it is not difficult to see that the conceptual frameworks for evaluating overall bank performance are similar. While Sinkey [11] clearly distinguishes between controllable and non-controllable factors, Fraser and Fraser [12] focus on those factors controllable by bank management. Similarly, Fraser and Fraser [12] use terms like computer operations, communications, personnel development, which are also inherently part of Sinkey's [11] income production and expense control factors. Whatever the author's choice of words, they are the factors that determine return (profitability) and risk.

This section has highlighted how overall bank performance, as represented by shareholders' wealth, can be investigated under the two principal dimensions of profitability and risk.[4] Factors shaping these dimensions can be separated into those controllable by bank management and those that are essentially non-controllable by bank management. The ability to distinguish between controllable and non-controllable variables is significant in choosing the correct research design and mathematical programme to explain environmental influences. In the next section, we identify specific measures used under various dimensions of bank performance analysis.

3. Key measures of bank performance

Disaggregation of overall performance into various sub-dimensions opens the way to capture interactions amongst potential inputs and outputs with a view to benchmarking (DEA is a useful

[4]We should point out that, for brevity, the review of bank performance has so far followed a path of traditional finance theory. We do not address ethical and environmental performance dimensions but acknowledge them as potential extensions of this study.

Table 1
Key financial ratios in bank performance analysis (adapted from [12, pp. 91–100, 15])

Summary ratio (overall performance) Net income/average equity (ROE)[a]	
Profitability ratios	**Risk ratios**
Net income/average assets (ROA)[b]	***Overall risk***
Net interest income/average assets	Primary capital/adjusted average assets (reciprocal of the EM[c] with adjustments)
Interest income/average assets	Growth rate of assets
Interest income/average earning assets	Growth rate of primary capital
Interest expense/average assets	Cash dividends/net operating income
Interest expense/average earning assets	***Credit risk***
Non-interest income/average assets	*Net loss/total loans and leases*
Non-interest expense/ average assets	*Earnings coverage of net loss*
Personnel expense/average assets	*Loss reserve coverage of net loss*
Occupancy expense/average assets	*Loss reserve/total loans and leases*
Other operating expense/average assets	Percent non-current loans and leases
Provision for loan and lease losses/average assets	Provision loan loss/average assets
Realised gains or losses on securities held to maturity	***Liquidity***
Realised gains or losses available on securities for sale	Temporary investments/volatile liabilities
Net extraordinary items/average assets	Volatile liability dependence (volatile liabilities less temporary investments divided by sum of net loans, leases, and debt securities over 1 year)
Applicable income taxes/average assets	Loans and leases/assets
	Interest rate
	Gap (difference between the rate sensitive assets and rate sensitive liabilities)
	Fraud risk
	Officer, shareholder loans/assets

[a]Return on equity.
[b]Return on assets.
[c]Equity multiplier.

tool in such an exercise). For example, at the end of Section 2.1, we were able to identify four key aggregate variables that influence wealth maximisation, namely, interest income, non-interest income (i.e. fee income), interest expense, and non-interest expense (e.g. salaries).

Continuing the search for potential input–output variables, Table 1 (sourced from [12] and updated through [15]), reviews key financial ratios on overall performance, profitability, and risk based on the Uniform Bank Performance Report from the US.[5] Similar profitability ratios are also reported in van Greuning and Bratanovic [16, p. 99]. Tables 2 and 3 further list selections of key measures used in the Australian industry report Financial Institutions Performance Survey [18] and those used by the Canadian investment brokers Wood Gundy and Richardson

[5]Uniform Bank Performance Report is based on balance sheet and profit and loss statement information submitted by insured banks.

Table 2
Selected key measures used by the Australian banking sector analysts (adapted from [18, pp. 42–43])

Strength and soundness	**Size**	**Growth**
Net assets	Total assets	Increase in total assets
Tier 1 & Tier 2 capital	Total risk weighted assets	Increase in operating profit after tax
Capital adequacy ratio	Number of employees FTE[a]	
Profitability	**Efficiency**	**Credit quality**
Operating profit after tax (OPAT)	*Operating expenses*/WATA	Loan write-off/*net interest income*
OPAT/weighted average total assets (WATA)	*Operating income* per employee	Net non-accrual loans/shareholders' equity
Interest margin[b]	*Operating expenses*/operating income	
Interest spread[c]		
Non-interest income/WATA		
Underlying performance[d]		

[a]FTE stands for full-time equivalent.
[b]Net interest income/average interest earning assets, where net interest income equals interest income less interest expense.
[c]Average rate on average interest earning assets, minus average rate paid on average interest bearing liabilities
[d]Net interest income plus non-interest income, less operating expenses.

Table 3
Selected key measures used by the Canadian Banking Sector analysts (adapted from [19, pp. 164–167])

Profitability	**Earnings, book value and dividends**
Return on average assets (after preferred dividends)	Earnings per common share
Common equity leverage	Basic value per share
Return on common equity	Dividends per common share
	Payout ratio
Assets growth	**Assets and credit quality**
Total assets	Non-performing loans and acceptances (net of provisions for losses)
Liquid assets	Net non-accrual loans
Securities	Allowances for losses
	Write-offs
	Loan loss provision
Funding	**Income statement**
Canadian dollar core deposit to total loan ratio	*Underlying net interest margin*
Total wholesale funding to total assets ratio	*Reported net interest margin*
Tier 1 ratio	Comparative loan loss provisions as a percentage of average assets
Fees, expenses and income	**Market share**
Fees as a percentage of total revenue	Percentage market share of individual loan balance
Non-interest expenses	Percentage market share of individual deposits
Net interest income	Percentage market share of residential mortgages
Other income	

Greenshields (as reported in [19]) respectively. The four key variables can be seen in italic font under the headings of profitability ratios (Table 1), profitability, efficiency, and credit quality (Table 2), and fees, expenses and income, and income statement (Table 3).

The discussion so far has identified a number of dimensions, variables and ratios suggested by theory and practice. However, we have not discussed any theoretical models of banking that could help categorise variables into inputs or outputs for efficiency analysis. The next section reviews key bank behaviour models that can help classify variables capturing the essence of a bank's operations into inputs and outputs.

4. Modelling bank behaviour

4.1. Overview

While there is no consensus amongst researchers about the inputs and outputs of a bank, there are two principal schools of thought on bank behaviour. One of these is the production approach where banks are regarded as using labour and capital to generate deposits and loans. The other is the intermediation approach to modelling bank behaviour where deposits are regarded as being converted into loans. These two models are further expanded later on in this section.

A third approach to modelling bank behaviour is that of value-added [14]. Under this approach, high value creating activities requiring large expenditures on labour and physical capital such as making loans and taking deposits are classified as outputs and measured in dollar terms, whereas labour, physical capital and purchased funds are classified as inputs [20]. The value-added approach can be regarded as a variation of the production approach.

A fourth approach is known as user-cost, which assigns an asset as an output if the financial returns are greater than the opportunity cost of funds. Similarly, a liability item is regarded as an output if the financial costs are less than the opportunity cost. If neither of these conditions is satisfied, the asset or the liability is classified as input [14]. The user-cost approach is usually attributed to Hancock [21]. According to Hancock, user costs can be calculated for all the assets and liabilities on the balance sheet. However, the assignment of assets and liability items as inputs or outputs may change with movements in interest rates and service charges. In its implementation, the user-cost approach remains difficult at best and in most countries the kind of disaggregated specific data required elude those external to the financial institution. Other implementation problems include generally unobservable asset and capital prices in the next period, the choice of discounting rate and depreciation rate [13].

Historically, a substantial proportion of the disagreement in selection of bank outputs has been due to the implicit pricing of bank services [14]. For example, the compensating balance required with most deposits implies that interest is effectively paid at below-market rates. It also implies that the implicit revenues are earned on the compensating deposit balances. Thus, explicit revenues can become an unreliable indicator of service flows or outputs. While the production approach tries to address this shortcoming by measuring outputs as a number of accounts or transactions, such measures are not easy to come by in practice. Fortunately, compensating deposit balances are becoming more difficult to justify in an environment of fiercer competition in post-deregulation banking. Furthermore, where compensating balances are required (in retail

Table 4
A general technical efficiency model based on the production approach

Inputs	Outputs
• Full-time equivalent (FTE) number of employees • Occupancy, furniture and equipment expenses ($) • Other non-interest expenses ($)	• Number of demand deposits • Number of time deposits • Number of real estate loans • Number of installment loans • Number of commercial loans

banking), the customer almost invariably receives a free service, such as a small number of free across-the-counter or ATM transactions.

The following more detailed guidelines are provided for the benefit of those who would like to follow one of the two principal schools of thought on bank behaviour, namely, the production or the intermediation model, in choosing inputs and outputs.

4.2. Production approach

Under the *production approach*, the objective of banks is to minimise the consumption of resources in providing various products and services, or maximise products and services for given levels of resources. Hence, the essence of production modelling is to identify those resource inputs that are key to producing the main outputs, where outputs are usually measured in number of accounts or transactions rather than dollars. For example, the main inputs and outputs of banks can be regarded as (adapted from [22]):

In Table 4, the main non-interest expense category, salaries, is represented by number of employees. Due to its stronger focus on operations where interest expenses are normally ignored, the production approach is more appropriate for the study of operating efficiency. The production approach can be traced to Towey [23] who regards demand deposits as the main output of commercial banks. The listing of outputs can easily be extended to include some of the other key activities of modern retail banking such as funds management and insurance.

4.3. Intermediation approach

Alternatively, under the *intermediation approach*, as the name suggests, banks are regarded as intermediaries in raising funds in the form of deposits and other funds (such as insurance policy holder liabilities), and lending funds in the form of loans and other assets (such as insurance investments) to generate earnings. In this asset approach, the funds raised and the expenses incurred in the intermediation process are normally treated as inputs, whereas the funds loaned and income generated are regarded as outputs. According to Sealey and Lindley [24], who are often credited with introducing the now popular intermediation approach, designation of only earning assets as outputs is consistent with rational profit maximising behaviour. Hence, the objective of banks is considered as implementing this transfer process efficiently where outputs are maximised and/or inputs minimised. As the intermediation approach effectively takes into

Table 5
A general technical efficiency model based on the intermediation approach

Inputs	Outputs
• Deposits ($) • Debentures ($) • Other liabilities ($) • Shareholders equity ($) • Full-time equivalent number of employees • Physical capital ($) • Other non-interest expenses ($)	• Loans ($) • Securities ($) • Deposits with other banks, except the central bank ($) • Non-interest income (proxy for fee-based products/services) ($)

account both operating and interest expenses, it is often considered as more appropriate for investigating economic viability [20]. The examples of key inputs and outputs in Table 5 have been adapted from Kaparakis et al. [25] and Aggarwal [19].

On the inputs side, deposits, debentures and other liabilities would be correlated with interest expenses, and the number of employees and physical capital would be correlated with non-interest expenses. On the outputs side, loans, securities and deposits with other banks would be correlated with interest income. In situations where disaggregated data are not available or variable parsimony is important in designing a discriminating DEA efficiency model with a small sample size, inputs can principally be represented by interest expense and non-interest expense, while outputs can be represented by interest income and non-interest income. Correlation analysis can be used to help select inputs and outputs, where we would normally favour high correlations between inputs and outputs in building a discriminating efficiency model, and low correlations within inputs (outputs) to reduce redundancy.

Where the variables in an efficiency model have different dimensions (i.e. physical input proxies combined with dollar outputs), then the researcher needs to pay attention to the type of mathematical DEA model used. For example, the BCC model [26] or, the CCR model [27], while producing units-invariant or dimension-free radial inefficiency estimates, does not generate units-invariant estimates of non-radial inefficiency[6] (see [28]). For consistent interpretation of DEA estimates, we need to choose a fully units-invariant DEA model such as the slacks-based measure (SBM) of efficiency (see [3, p. 97, 29]).

This section has presented a theoretical framework for classifying variables into inputs and outputs. However, the different approaches outlined are limited to those models of bank behaviour we are most likely to come across in empirical productivity studies. We acknowledge that there are many other theoretical models that focus on various aspects of banking, which are outside the scope of this study. The interested reader is referred to Swank [9] for a survey of theoretical banking literature that models microeconomic bank behaviour, and Bhattacharya and Thakor [30] where the focus is on existential theories of banking that try to identify the circumstances under which intermediation can be viable. The next section identifies the key

[6]Radial inefficiency refers to the proportional reduction in inputs or rise in outputs before a DMU is considered efficient. Non-radial inefficiency is traditionally known as 'slacks'.

motivations for establishing foreign banks, which are mainly involved in wholesale banking or niche financing.

5. Motivations for establishing foreign banks

We examine the potential motivations behind setting up banking operations in foreign countries with the expectation of gaining further insight to which variables should be included in efficiency measurement. This survey of empirical literature focuses on those studies that treat the foreign bank as part of a multinational corporation. The literature survey reported here is limited to the hypotheses of international bank behaviour and performance identified by Williams [31] as having empirical support after his extensive literature review.

5.1. Defensive expansion and trade finance hypotheses

Defensive expansion and trade finance hypotheses are two of the most extensively tested theories that try to explain international bank behaviour. Defensive expansion hypothesis suggests that a bank (in its home country) is prepared to follow clients abroad (into a host country) for fear of losing the business relationship. Empirical testing of this hypothesis is often carried out through a proxy that measures direct investment by the home country in the host country (e.g. [17,32–36]). Most empirical tests report a positive and significant relationship between direct investment by the home country in the host country and foreign bank activity in the host country (often measured by branch total assets, number of foreign banks, foreign bank's share of total bank assets, or number of staff).

Trade finance hypothesis is regarded as a variation of the defensive expansion hypothesis where the bank follows clients' trading activities instead of their investment activities. Cho [37] argues that trade financing is an important transaction service that is part of the true expertise of international banks. It is further argued that such expertise can be provided at low transactional cost, and that the foreign bank can benefit from low marginal cost of production by operating in a host country with substantial trade with the home country. A common trade finance proxy is exports and imports between the home and host countries (see [32,38–42]). However, empirical studies report a mixture of positive and negative significant relationships between foreign bank activity in host country and trade finance.

5.2. Home market sophistication hypothesis

This hypothesis is formed around the argument that banks from more developed capital markets have more sophisticated skills that they can use in foreign markets [40]. In general, proxies for measuring home market sophistication relate to the size of home country capital market, e.g. total deposits, bank market size, and financial market size. Such proxy measures often have positive relationships with host country market activity, i.e. foreign bank activity in the host country. Other studies that lend empirical support to the home market sophistication hypothesis include [32,43].

However, the above-mentioned proxies are measures of volume and do not necessarily capture the sophistication of banks in the home countries. In fact, there is no easy way to measure the level of sophistication of the skills of foreign banks. Another confounding factor here would be the presence of foreign banks from less developed capital markets which would contradict the main argument behind the hypothesis.

5.3. Host size hypothesis

Host size hypothesis proposes that international banks would be drawn to countries that provide opportunities for growth. It is argued that growth opportunities will be greater in larger countries, where higher sales volumes are more likely [44]. Nigh et al. [45] also argue that growth opportunities will be greater in larger markets and that banks will expand overseas to exploit such local opportunities. Banks would also be drawn to large overseas markets in an attempt to diversify portfolio risks. A variety of host size proxies have been used in empirical testing, including host/home country relative GDP [37], industrial production index [46], ratio of loans by foreign bank to total host country loans [42], total state banking assets [47] and host country GNP [34,48]. Most proxies have a positive and significant relationship with the level of foreign bank activity in the host country.

5.4. Host nation competition hypothesis

This hypothesis links foreign bank activity to competition in the host country. The inverse relationship suggests that higher local (indigenous) bank activity would mean fewer opportunities for foreign banks to set up shop in a new market [34]. Host nation competition proxy measures with significant results include rate of return on branch assets [39], domestic deposits [34], and ratio of assets held by major local banks to total bank assets of the host country [42].

5.5. Parent size/capital base hypothesis

Under this hypothesis, the size of a bank's capital base (i.e. parent size) is regarded as one of the determinants of competitive success in overseas operations [49]. Proxy measures of parent size that show positive and statistically significant correlations with foreign bank activity include relative asset size [50], equity capital, deposits, and number of countries in which the bank has operations [37], total bank assets, and capital to assets ratio ([51], and foreign direct investment in the host country [36]).

5.6. Efficiency variables based on the preceding hypotheses

Defensive expansion hypothesis indicates a positive and statistically significant relationship between direct investment by the home country in the host country and foreign bank activity (see end of this section for a list of foreign bank activity measures). This suggests that direct investment can be included as a non-discretionary input variable and bank activity can become an output in efficiency modelling. That is, the businesses set up in the host country define the potential market for the operations of the foreign bank. While the foreign bank manager will have

no control over direct investment, it becomes an environmental input by virtue of its impact on bank outputs such as loans, securities and fee income.

Other hypotheses on motivations for establishing foreign banks point to at least one more environmental variable that could also become part of efficiency analysis. For example, parent size can be considered as another non-discretionary input likely to influence foreign bank activity and success in a positive and statistically significant relationship. That is, the parent bank's capital base provides an easily accessible resource (i.e. source of inputs in the production process) for the foreign bank.

Summarising the contribution of Section 5, two new potential non-discretionary input variables emerge, namely, *foreign direct investment by home country in host country* and *parent size*. Examples of measures of foreign bank activity used by the authors cited in the discussion of the empirically supported hypotheses are listed below:

- Foreign bank assets
- Foreign bank's share of total bank assets in host country
- Foreign bank's share of total commercial bank loans in host country
- Foreign bank's share of total commercial bank deposits in host country[7]
- Foreign bank net income
- ROE
- ROA
- Number of staff
- Number of foreign bank subsidiaries/branches/offices.

The above list of potential inputs/outputs closely corresponds to various measures summarised in Section 3. In the following section, we put up three efficiency models that emerge from the discussion so far.

6. Proposed efficiency models for foreign banks

6.1. Summary of the process for developing foreign bank efficiency models

The preceding sections have laid down a sound theoretical foundation. In summary, we began by acknowledging the place of banking in the theory of finance. We then quickly focussed the discussion on shareholder wealth maximisation within financial institutions. Initial conclusions (in Section 2.1) revealed four key variables. In Section 2.2, we outlined risk–return frameworks in banking and demonstrated how they related to wealth maximisation. In the process, we identified various controllable and non-controllable factors that shape the profitability and risk dimensions of a bank's performance.

In Section 3, we identified the key financial ratios in bank performance measurement. ROE is presented as a measure of overall performance, where ROA and EM capture profitability and risk

[7]The first four measures in this list can be misleading in the presence of regulatory restrictions on loans and/or deposits.

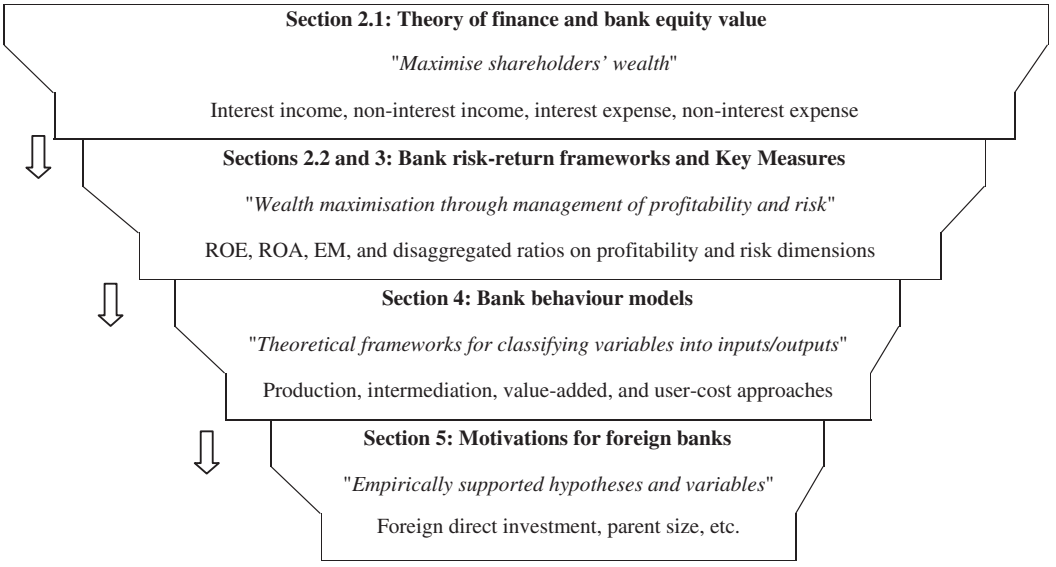

Fig. 4. Overview of the process laying the theoretical foundation for foreign bank efficiency modeling.

dimensions, respectively. Examination of various sub-dimensions of profitability and risk produced a wealth of measures suggested by the literature and used by industry analysts, where the four key variables identified in Section 2.1 were observed as part of profitability measures. We acknowledge that use of disaggregated measures (instead of ROE or ROA) can lead to useful benchmarking studies particularly enabled by DEA.

Having identified a number of dimensions, variables and ratios suggested by theory and practice, in Section 4, we then reviewed the established bank behaviour models often used in input–output selection. This section laid the theoretical foundation for identifying variables as either an input or an output, with a particular emphasis on the popular production and intermediation approaches. In Section 5, we reviewed the potential motivations for establishing foreign banks, which brought us a step closer to developing efficiency models for foreign banks. Based on a number of empirically supported hypotheses of international bank behaviour and performance, we identified two non-discretionary input variables, and a number of other inputs and outputs measuring foreign bank activity. Fig. 4 summarises this process.[8]

6.2. *Using insights from theory to build technical, cost and profit efficiency models*

The next step involves linking the insights from the theoretical frameworks outlined in Fig. 4 to developing technical, cost, and profit efficiency models for foreign banks. To address technical efficiency, the production approach to modelling bank behaviour would be used because the main focus is on operating efficiency. Under this approach, the often-repeated objective of banks is to minimise the consumption of resources, thus suggesting an input orientation; alternatively, banks

[8]The process summarised in Fig. 4 can be generalised, say, for retail banks instead, by replacing the last step, i.e. motivations.

Table 6
A foreign bank technical efficiency model based on the production approach

Key inputs	Key outputs
1. Subsidiaries/branches/offices (#)	1. Loans (#)
2. Employees FTE[a] (#)	2. Securities[b] ($)
3. Other non-interest expenses[c] ($)	3. Deposits with other banks, except the central bank (#)
4. *Foreign direct investment* (*n*/*d*)[d] ($)	4. Deposits (#)
5. *Parent size in total assets* (*n*/*d*) ($)	

[a]Full-time equivalent.
[b]This output is not conducive to being counted.
[c]Other non-interest expenses include advertising, general expenses, professional fees, and business taxes.
[d]*n*/*d* stands for non-discretionary; foreign direct investment by home country in host country.

Table 7
A foreign bank cost efficiency model based on the production approach

Key inputs	Input costs	Key outputs
1. Subsidiaries/branches/offices (#)	Occupancy, furniture and equipment expenses ($)	1. Loans (#)
2. Employees FTE[a] (#)	Labour expenses ($)	2. Securities[b] ($)
3. Other non-interest expenses[c] ($)	Item 3 cost can be assumed uniform across banks, i.e. unity[d]	3. Deposits with other banks, except the central bank (#)
4. *Foreign direct investment*[e] (*n*/*d*) ($)		4. Deposits (#)
5. *Parent size in total assets* (*n*/*d*) ($)		

[a]Full-time equivalent.
[b]This output is not conducive to being counted.
[c]Other non-interest expenses include advertising, general expenses, professional fees, and business taxes.
[d]That is, the unit cost of advertising, general expenses, etc. are assumed to be the same across banks operating in a competitive environment.
[e]*n*/*d* stands for non-discretionary; foreign direct investment by home country in host country.

can aim to maximise outputs for given input levels. Essentially, production modelling seeks to identify those resource inputs that are key to generating the main outputs (usually measured in number of accounts or transactions; where a count is not available, a dollar value is substituted). Hence, the various key variables/measures to emerge from theory are classified as follows in Table 6:

The technical efficiency model can be adapted for cost efficiency by identifying the costs of inputs. We define cost efficiency as the ratio of the minimum production cost observed in the sample to the actual production cost of the bank examined. Using the above model as our starting point, we end up with the model shown in Table 7:

To address revenue and profit efficiency, the intermediation approach to modelling bank behaviour would be used because the main focus here is on profit maximisation and economic viability. To calculate revenue efficiency we need data on output prices and to calculate profit

Table 8
A foreign bank profit efficiency model based on the intermediation approach as suggested by literature

Key inputs	Input costs	Key outputs	Output prices
1. Deposits ($)	Attributable interest expenses ($)	1. Loans ($)	Attributable interest income ($)
2. Shareholders equity ($)	Dividends ($)	2. Securities ($)	Attributable interest income ($)
3. Subsidiaries/ branches/ offices (#)	Occupancy, furniture and equipment expenses ($)	3. Deposits with other banks, except the central bank ($)	Attributable interest income ($)
4. Employees FTE[a] (#)	Labour expenses ($)	4. Non-interest income or fee income (proxy for fee-based products /services) ($)	Item 4 price can be assumed uniform across banks, i.e. unity[b]
5. Other non-interest expenses [c] ($)	Item 5 cost can be assumed uniform across banks, i.e. unity	5. Underlying performance[d] ($)	Item 5 price can be assumed uniform across banks, i.e. unity
6. Equity multiplier[e]			
7. Impaired loans[f]			
8. *Foreign direct investment*[g] (*n/d*) ($)			
9. *Parent size in total assets* (*n/d*) ($)			

[a]Full-time equivalent.
[b]That is, the unit price of fee-based services is assumed to be the same across banks operating in a competitive environment.
[c]Other non-interest expenses include advertising, general expenses, professional fees, and business taxes.
[d]Net interest income plus non-interest income, less operating expenses (non-interest expenses).
[e]Measure of potential risk exposure, where equity multiplier is defined as average assets/average equity.
[f]Measure of success in risk management.
[g]*n/d* stands for non-discretionary; foreign direct investment by home country in host country.

efficiency we need data on both input costs and output prices. Under the intermediation approach, the funds raised and the expenses incurred in the intermediation process are normally treated as inputs, whereas the funds loaned and income generated are regarded as outputs. The risk dimension is introduced in the key inputs of EM and impaired loans, thus linking the model of economic viability to the conclusions drawn in Section 2.2.2.[9] Hence, the various key variables/ measures to emerge from theory are classified as follows in Table 8:

Our suggestion to capture the risk dimension through input variables warrants further comment. For example, given EM's definition, a smaller EM ratio is desirable because it will represent a smaller financial risk exposure (leverage). This is consistent with the concept in efficiency modelling that *inputs* should be variables that are desirable in smaller quantities and *outputs* are desirable in larger quantities. Yet, EM can also be treated as an output. If we bring microeconomic theory of bank production to bear on the issue, then we can put up the alternative

[9]Stanton [52] uses risk level as an input as well.

argument that risk management is an important output of the intermediation process where the bank pools and reduces the risks for the investor. As an output, it would then be appropriate to measure risk exposure through the reciprocal of EM. Similarly, impaired loans is a measure of how successful a bank is in managing its loans portfolio and ultimately this is traditionally handled as part of risk management. That is, the arguments presented in this paragraph for the EM ratio being used as an input or an output hold for impaired loans as well.

To summarise, in the efficiency models outlined above, key variables identified in Section 2.1, namely, interest expense, non-interest expense, interest income, and non-interest income, are represented mostly indirectly, e.g. loans would be highly correlated with interest income and deposits with interest expense. Similarly, the proposed profit efficiency model addresses profitability and risk dimensions discussed in Section 2.2 in the choice of inputs and outputs. For example, income and expense generating variables probe profitability, while EM and impaired loans are measures of risk. Also, use of disaggregated variables makes these efficiency models conducive to benchmarking studies, which is a point we first made in Section 3. By developing two efficiency models based on the production approach and one model based on the intermediation approach, we acknowledge the well-established models of bank behaviour (see Section 4). Use of the two non-discretionary input variables that emerged from Section 5 further enriches the models by opening the way for analysis of environmental influences on foreign bank efficiency. For example, such studies can combine DEA with stochastic frontier analysis, allowing for further separation of statistical noise and environmental influences from managerial inefficiency (e.g. [53,54]).

7. Conclusion

The theoretical models of technical, cost and profit efficiency outlined above can be used as starting points for empirical research in the quest for a better understanding of foreign bank efficiency. We also note that researchers often improvise on theoretical models. This, of course, is quite an understandable approach to empirical research in banking where data on specific variables suggested by theory are often inaccessible or unavailable, the researcher is limited to small sample sizes and as a result, comprehensive efficiency models with many inputs and outputs are simply not feasible.[10] Nevertheless, while availability of data and sample size are factors often outside the control of the researcher, this does not justify neglecting the use of existing theories as a foundation for empirical research. In fact, many empirical studies on application of DEA to bank efficiency have relied on a variable selection process that is poorly explained, where the linkages between theory and variables are not always clearly identified.

Bringing together finance and banking theories to bear on foreign bank efficiency modelling is the main contribution of this study to the theory of bank performance. For the first time, theory of finance, frameworks for bank shareholder wealth maximisation through management of risk and return, bank behaviour models for classifying variables into inputs and outputs, and theories of foreign bank motivations have been brought under the same roof. Another major contribution

[10]US is one of a few exceptions to this rule where much disaggregated data are available through the Uniform Bank Performance Report on a large number of banks.

of the study is development of efficiency models adapted to foreign banks where non-discretionary inputs based on motivations are new additions. We expect this study to become a catalyst in generating comparable empirical bank productivity studies and provide direction for further efficiency model development by emulating the demonstrated process. Such an empirical paper has recently been accepted for a conference presentation (see [55]).

There are also certain policy implications of developing efficiency models through the process demonstrated in this study. For example, acknowledging the contribution of risk–return management to shareholder wealth creation reduces the potential for agency costs to the firm. Similarly, introducing environmental variables provides a more accurate measure of managerial efficiency, thus facilitating decision-making both at bank level and at the level of regulatory agencies engaged in performance monitoring as well as de-regulation and/or re-regulation deliberations. Finally, following a process of efficiency modelling that is disciplined by the theory of finance and banking brings increased confidence to long-term decision-making where comparability across time becomes more important.

Possible extensions of this study can explore ways to measure ethical and environmental dimensions of foreign bank performance with a view to identifying inputs and outputs that can be incorporated into new efficiency models. Such studies can borrow from the rapidly expanding literature of socially responsible investments. While retail banks have recently made some progress towards identifying key performance indicators on non-financial dimensions, foreign banks have been under much less pressure due to their low public profiles.

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