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Risk Management and Managerial Efficiency in Chinese Banks: A Network DEA Framework

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Abstract

Risk Management in Chinese banks has traditionally been the Cinderella of its internal functions. Political stricture and developmental imperative have often overridden standard practice of risk management resulting in large non-performing loan (NPL) ratios. One of the stated aims of opening up the Chinese banks to foreign strategic investment is the development of risk management functions. In recent years NPL ratios have declined through a mixture of recovery, asset management operation and expanded balance sheets. However, the training and practice of risk managers remain second class compared with foreign banks operating in China. This paper evaluates bank performance using a Network DEA approach where an index of risk management practice and an index of risk management organisation are used as intermediate inputs in the production process. The two indices are constructed from a survey of risk managers in domestic banks and foreign banks operating in China. The use of network DEA can aid the manager in identifying the stages of production that need attention.

Keywords: Risk Management, Risk Organisation, Managerial Efficiency, Network DEA

JEL Classification: D23, G21, G28

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1. Introduction

In recent years the Chinese banking system has made enormous strides in reform and deregulation. They have emerged relatively unscathed from the global banking epidemic that has infected the developed economies and the largest of them stand alongside the giants of global banking as first among equals.[1] However, despite the relative strength of the large listed Chinese banks in world banking, lingering doubts remain about the inherent fragility of the banking system in China. The past decade has seen a large volume of academic and professional papers expressing concerns about the safety and soundness of the Chinese banking system and their medium term viability in the face of increasing competition from foreign banks in the post WTO years. The common thread in many reviews of Chinese banking are; the large number of non-performing loans, the dominance of lending to state-owned enterprises, and the influence of local government and Communist Party officials in lending decisions.

A particular area of concern for the regulatory authorities and strategic investors in the Chinese banks has been the quality of training of risk managers, the organisational culture and the misalignment of incentives associated with bureaucracy rather than commercialism (Hamid and Tenev, 2008). The process of converting Chinese banks from state dominated bureaucracies to modern profit oriented banking institutions involves not just the training of decision makers in modern banking but also the transformation of the organisation. This transformation has been occurring but on an evolutionary rather than a revolutionary pace. With the encouragement of the regulatory authorities, Chinese banks have in recent years, had to restructure their balance sheet, develop modern risk management methods, improve capitalization, diversify earnings, reduce costs and improve corporate governance and disclosure.[2]

This paper aims to construct a metric of risk management practice, and risk management organisation in Chinese banks, using the foreign banks as benchmarks of best practice. The metric will measure how good the practice of risk management is in a Chinese bank and how well the risk management function organisation is relative to best practice. The metric can be used to rank banks not just on objective measures of performance but also on the often hidden measures of organisational practice which can be viewed as inputs to overall performance and may aid the manager to target specific areas for the purpose of improving performance and efficiency. Information on the individual banks' risk management practice, organisation and training was obtained from interviews with risk managers and credit officers.

The paper is organised in the following way. The next section outlines the results of interviews. Section 3 describes how the interview responses are converted into a relative score benchmarked on two of the

[1] According to 1000 top bank survey in the July 2009 issue of the Bankers Magazine, the Industrial and Commercial Bank of China is the 8th largest in the world and Bank of China is 11th largest. For a statement of the development of the banking market see Yang and Kuhn (2007) Ch 3.

[2] CBRC Annual Report 2006 http://www.cbrc.gov.cn/english/home/jsp/index.jsp

major foreign banks operating in China (HSBC and Citibank). Section 4 describes the method of performance evaluation based on Data Envelopment Analysis (DEA) and the use of network DEA to think of risk management and organisation as an intermediate output/input in the process. Section 5 summarises the results and concludes.

2. Qualitative Analysis

Twenty five bank executives involved in the area of lending and risk management were interviewed over the period 2007-8. The banks included three foreign banks, the big 4, nine joint-stock commercial banks and two city commercial banks. The criteria for choosing interviewees were that they were involved in the risk management function and the lending decision with several years experience. The aim was to get middle ranking managers who could explain existing risk management practice and provide subjective evaluation of staffing, training and recruitment issues.

The interviews were conducted in a semi-structured format in which interviewee responses were recorded and respondents recorded their own scores (1 – 5 Likert scale) with respect to specific questions about risk management functions. Interviews were conducted in Beijing, Shanghai, Tianjin, Dalian, Guangzhou and Shenzhen. The appendix details the banks that were involved in the study and the acronyms used in subsequent tables.

The questionnaire was divided into three areas of the risk management operation. The first area was concerned with the importance of particular characteristics regarding the loan approval decision to specific sectors (large enterprises, SMEs and consumers). The second area covered the types of quantitative and qualitative tools used within the bank to aid the risk management process. The third area covered the organisation, training and staffing of the risk management section of the bank. This section dealt with issues relating to performance evaluation, training, recruitment, retention and work organisation. The appendix details the questionnaire and the mnemonics of the banks in the sample.

Most interviews were conducted in an informal setting (lunch or tea) but on some occasions interviews were carried out in the interviewees office.[3] The principal aim of the interviews was to obtain a numerical score relating to the risk management function within the bank based on the value judgement of the interviewee. At the outset the interviewee was asked to provide some comments about the lending policy of the bank and to state the three main factors that determine loan approval. The responses varied from stating the PBOC guidelines for lending to State-Owned-Enterprises (SOE) and Small and Medium Enterprises (SME), to stating key factors without elaboration. The single largest factor in the granting of

[3] The non-work environment for the conduct of the interviews turned out to be quite important. The respondent was a lot more relaxed and volunteered a wider perspective on the organisation of their respective bank. While none of the questions could be deemed to be politically or commercially sensitive, interviewees in the work environment responded cautiously to questions. For a discussion of the advantages and disadvantages of informal interviewing see Bewley (2002).

a loan was cash flow (70%),[4] which biases bank lending to established enterprises. Record of repayments (good credit record) was cited by 30% of respondents. A preference for lending to SOEs (65%) reflects the political reality of state and local government relevance in the lending decision as well as implicit government guarantees. Collateral was not an issue except in the case of lending to SMEs. Less than 20% of interviewees considered collateral and guarantees as important in the lending decision reflecting the dominance of SOEs in the bank's loan portfolio. Collateral was a more important feature for the two foreign banks reflecting the stronger focus of these banks in the SME sector. In the case of mortgage lending, there was no common formula relating loan size to annual income. The most common cited reason for approval of a mortgage was the type of job the borrower had. Government officials, civil servants and employees in large SOEs were viewed as having the safest jobs and lowest risk (65%). Income levels, ability to pay and volatility of income was cited as the second main factor in determining mortgage approval (25%). Loan-to-Value of mortgages does not exceed 80% and typically are in the region 60-65% with normal upper bound of 70%.

The reasons for a loan refusal had a greater variation in the response. The single main reason for a loan refusal to a SOE was weak financial projections (36%) which, was also linked to any history of delinquency (18%). However, the second single factor was state policy. Even if an enterprise is state owned, it may be classified as belonging to a declining industry with weak state guarantees (27%). In contrast, the foreign banks saw independence of SOE management from the state as a strength and cited poor management quality as the principal reason for loan refusal to a SOE.

In the case of SMEs, the principal reason for loan refusal was the lack of collateral or third party guarantee (36%). One respondent stated that collateral substituted for post-loan monitoring and was viewed as the price for the loan. Weak financial and cash projections were the second most cited reason (27%) and poor credit record or lack of credit record was the third most cited reason (22%). The response of the domestic bank risk managers highlights the conservativeness of the lending decision to SMEs. Start up companies would be considered high risk and only established SMEs with good collateral and financial history stand much chance of a loan approval. The foreign banks also viewed start ups as risky but even with good financial projections and solid third party guarantees, the strength of the company's management was a determining factor in loan refusal. Only one of the domestic bank's respondents stated that the quality of management was a significant factor in loan refusal to SMEs.

The policy on remuneration, incentives and performance evaluation varied widely. One of the big-4 had no formal performance related compensation system. Bonuses were determined by the Chief Risk Officer at headquarter, but there was a recognition that risk managers that recovered NPLs were worthy of special reward. For this particular bank, the quantity or frequency of approvals was not a factor in

[4] The percentages are of the total number of respondents of the domestic banks and not the number of banks surveyed. The number of respondents per bank was 1-3. Appendix 2 gives the total number of inteviewees.

determining the final bonus. Under-performance led to transfer. Except in the case of fraud, redundancy was not a policy option. With two other big-4 banks, profit from the loan was the principal factor in performance evaluation and NPL recovery was the next important factor. While the frequency or number of approvals did not affect the evaluation, the overall profit of the unit was the main factor. With one of these big-4 banks, poor performance led to transfer or payment of basic salary (zero bonus). With the third bank in the big-4 group, the risk manager received 50% of compensation as basic and 50% as bonus but the evaluation was done by the General Manager rather than an independent Risk Manager, giving rise to the potential of moral hazard and adverse incentives.

With the interviewees of the joint-stock banks (JSB), the frequency and size of approvals was cited as many times as the profitability of the loan book. Only one interviewee of a JSB mentioned moral hazard as a reason for separating the bonus package for risk staff from the approvals decision making process. But in contrast, one other interviewee of a JSB specifically stated that the principle of a separation between the Sales/Business side of bank operations and the risk management function was impractical. As each branch is its own P&L centre, the political and business pressure on the approvals process detracted from any attempt of independence. The local bank president had considerable influence over the local risk management team. A second interviewee of a JSB stated that the Sales /Business side of the bank was an important consideration for the determination of bonuses to risk management. A third interviewee said that the local bank president has considerable influence on the local risk management team although the governance structure is changing. In the case of one small city commercial bank the risk personnel were evaluated in exactly the same way as non-risk staff and the bonus was based on position rather than performance.

Interviewees were asked to score the training of risk managers in their institution from a scale of [5] being excellent to [1] being useless. The benchmark score obtained from interviewing four managers from the two foreign banks was [5].[5] The median response from the Chinese bank managers was a score of [3] which was described as *adequate* with one-third of the sample scoring [2] as *inadequate*. Yet when asked to weight an incentive scheme against training to get the best performance from the risk team, the median response was 60% in favour of incentives and 40% for training. The benchmark defined by the interviewees of HSBC and Citibank weighted training as 70% and incentives 30%.

The comparison may not be appropriate as it is widely believed that the foreign banks pay their risk staff more than the domestic banks and therefore can indulge in greater training than the domestic

[5] Interviews with four risk management personnel from Citi Bank, HSBC and Bank of East Asia were conducted but only the responses from Citi and HSBC were used in defining the benchmark. The respondent from the Bank of East Asia was a recent employee and could not give answers to all the questions. The benchmark was defined as the 'envelope' of scores of the response of the three risk managers.

counterparts. While this perception is questionable,[6] the feeling that bonuses provide the appropriate compensation for risk staff is widely held and despite training only receiving a score of *adequate*, the general feeling was that marginally more resources should be targeted to creating stronger performance incentives.

A similar question relating to staffing levels in the risk team where the benchmark response was a score of [4], which is described as 'good' but not excellent ([5]) produced the following results. Three banks matched the benchmark and one exceeded it, but most recorded a score of [3] or [2]. The median score was [3]. There appeared to be no relationship between the perception of 'good' or 'excellent' and the position of the bank in the industry. The risk manager from the Industrial and Commercial Bank of China, one of the largest in the world, gave a score of [2] (inadequate) for staffing levels in the risk management field. In contrast four JSBs gave benchmark scores with the remaining big-4 SOB interviewees giving a score of [3].

The interviews also revealed information about recruitment and skills of bank personnel that were not covered in the questionnaire. One respondent of the big-4 said that 'many heads of sub-branches are not professional bankers but are retired army officers of 10-15 years experience. They tend to be appointed to high levels even as President or Head of HRM and even on the credit committee. While the chief risk manager is usually a professional and can veto a lending decision, the non-professionals wield influence and can affect decisions at the margin'. Another manager described his staff as principally 'government officials' that are procedurally driven rather than professional in the business of loan approvals.

3. Quantitative Analysis

This section describes the translation of the individual scores into a single relative metric. The questionnaire was divided into 3 main parts dealing with the lending decision (section 1), the tools and techniques employed in the risk management function (section 4), and the organisation, staffing, training, payment and retention of personnel engaged in the risk management function (section 5).[7] In the first and third parts, the interviewee provided scores relating to individual factors. In the second part, the interviewee indicated the tools the bank employed in risk management and the researcher entered a score based on a judgement of how close this was to the standard tools recognised as best practice.[8]

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6 It was learned in casual conversation that while basic pay of risk managers in domestic banks was lower than foreign banks, they often received higher end-of-year bonuses, soft loans and non-monetary benefits that were not available to those employed in foreign banks.

7 The questionnaire is presented in the appendix.

8 For example if a respondent said the bank uses something similar to Creditmetrics™ and went on to describe the model, the interviewer would give a subjective score between [1] and [5] where [5] would be equivalent to the Creditmetrics™ method.

The benchmark responses and the median of the domestic banks responses for each part are shown in the radar Figures 1 – 3.

Figure 1 plots the median responses against the benchmark for the 15 factors[9] relating to the lending decision for SOEs, SMEs and consumers. It can be seen that in all but one case the benchmark scores dominate the median responses. This suggests that the domestic banks focus on factors that are different from what Western banks think as primary factors in the lending decision.

Figure 2 shows the median scores and benchmark for 6 standard tools used in risk management. In order, these were RAROC or EVA in interest rate and fee pricing; credit scoring model (mortgages, credit card and consumer banking); credit committee for review of large scale loans; the calculation of a risk index based on balance sheet and income statements; the use of rating migration model or Value-at-Risk; and finally stress testing exercises.[10] Given the importance assigned to stress testing of the portfolio to Western banks by their respective regulators in the post crisis world it was interesting to note that according to the responses only four banks surveyed conducted stress testing with remainder having no knowledge of stress testing.[11]

Figure 3 shows the median and benchmark scores for the 11 factors relating to the training, staffing, reward, recruitment, and retention of risk staff. The largest deviations from the benchmark were for training [X17] and external recruitment [X21]. The foreign banks have a stronger policy of external recruitment of risk staff whereas domestic banks have typically recruited from within the organisation.

While Figures 1 – 3 show the correspondence of the median score against the benchmark scores, a test for independence of the distribution of the scores from benchmark values is shown in table 1. We use two statistical tests for independence. The 't' test is a small sample test but depends on the assumption of an asymptotic normal distribution. Since normality may not be an appropriate assumption, we employ a non-parametric test that is less restrictive in its assumption and only requires symmetry in the distribution. The Wilcoxon signed rank test, tests the median differences in paired data where one of the pairs is defined as the benchmark. Table 1 shows that except in the case of factor X3 (account profitability for SOEs)[12] the two statistics agree at the common level of significance (5%).

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9 The appendix provides the correspondence between the factor and the individual response to the specific question in the questionnaire.

10 As the interviewer, I made judgemental scores of tools that resembled the ones in the questionnaire. So for example if stress testing was in the form of scenario analysis and not in the context of VaR, a score of 4 was given rather than 5, or if knowledge of techniques were admitted to like KMV (distance-to-default) but not implemented a score of 2 was given.

11 One respondent suggested that since LTV of the mortgage portfolio was less than 70%, stress testing was unnecessary.

12 Both statistics were close to the critical values. The Wilcoxon test showed a significance level of 5.9% and the 't' statistic was only marginally larger than the critical value.

The results of Table 1 suggest important differences in the attitudes of Chinese domestic bank risk managers and Chinese foreign bank risk managers. For domestic risk managers the credit record and cash flow of the borrower (SOE and SME) are less important than for foreign banks. Similarly knowing your customer is much more important to the foreign bank risk manager than the domestic. A possible reason is that domestic banks concentrate their lending on SOEs that are implicitly guaranteed by the central and local government and have less of a focus on SMEs. Therefore rules about credit record and cash flow or KYC were historically less relevant to them.

A significant difference in importance of a person's credit record and credit score for a mortgage loan (X11) indicates the prevalent attitude that the type of job a person has is a better indicator of creditworthiness than income. A frequent response was that a government official was considered a good risk and a credit score or credit record was inappropriate.

A strong difference was noted in the scoring of the risk management training (X17) provided in domestic banks. As Figure 3 indicates, the median response was a score of [3] against a benchmark of [5]. Staffing levels were only *adequate* [3] or *inadequate* [2] against a benchmark of *good* [4]. External recruitment was also an important difference in the preferences between RMs in domestic banks and foreign banks. Foreign banks were more used to using Head-Hunters and agencies to recruit from outside the bank whereas this was not typical of Chinese banks which had a preference for recruitment within the bank.

Using the foreign bank scores as a measure of best practice the individual 5-point Likert scores of the domestic risk managers were benchmarked. The benchmarking principle was that negative scores (when the individual score was less than the benchmark score) were heavily penalised but positive scores (individual score greater than benchmark) were lightly penalised. The argument is that negative scores are indicative of downside risk whereas positive scores are overcautious but do not warrant an equivalent penalty. For example if the benchmark is that a certain factor is '*important*' (4) a score of '*not important*' (3) is given a heavier penalty than a score of '*very important*' (5). An asymmetric translation function on the lines of Surico (2008) produces the desirable properties. A translation function of the following type was used.

$$f(x) = \left\{ 1 + \frac{\frac{3}{2}x^2 - \frac{1}{2}x^3}{\gamma} \right\}^{-1} 100 \qquad (1)$$

where x = *response score – benchmark score* and γ is an arbitrary scaling parameter. The function described by equation (1) has the property of having a score of 100 when the respondents score equals the benchmark score but remains in the neighbourhood of 100 with a slight penalty for up to the value x = 2 (point of inflexion) when it starts to rise towards 100.

Figure 4 illustrates. It shows that negative values of *x* are heavily penalised and positive values are lightly penalised. The purpose of this type of translation function is to lightly penalise individual scores that weight specific factors greater than the benchmark but strongly penalise scores that are less than the benchmark. In reality no respondent exceeded the benchmark by more than 2 points on the score and it turns out that the translated score is not sensitive to the choice of the parameter γ.[13]

The deviation of the different scores of each sub-section from the respective benchmark were first transformed by equation 1 and then combined using a principal components analysis (PCA) to construct a single metric for each bank.[14] The fifteen transformed scores relating to the approvals function (denoted risk) were subjected to the PCA and the first principal component[15] was retained out of a possible five as a potential metric of risk for each bank.

The next step was to test the veracity of the principal component vector against an objective measure of risk. Following Hannan and Hanweck (1988), a risk index based on the probability of insolvency is defined as below;

$$\frac{E(ROA)+\frac{CAP}{A}}{\sigma_{ROA}} \tag{2}$$

ROA is the return on assets, *E(ROA)* is the mean of *ROA* over the 5 years to 2007, *CAP* is the bank's capital, A is its assets and σ_{ROA} is the standard deviation of *ROA* over the 5 years to 2007. Equation (2) is a risk index, measured in terms of units of the standard deviation of ROA. The index can be used to measure the probability of a decline in the bank's accounting earnings so that it has a negative book value and measures the thickness of the capital cushion relative to profit so that a higher measure indicates a safer bank.[16] The probability of insolvency can be obtained from the reciprocal of the index squared. By Chebyshev's inequality the probability of insolvency ρ will be given by;

$$\rho \leq \left(\tfrac{1}{2}\right)\frac{\sigma_{ROA}^{2}}{\left[E(ROA)+CAP/A\right]^{2}} \tag{3}$$

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13 The choice of the parameter influences the left side of figure 1 (negative deviations from benchmark) but has little effect on the right side (positive deviations). The continuity and monotonicity of the function ensures that the ranking remains consistent.

14 It is important to note that most mathematical operations including PCA may not be valid for Likert scaled variables being ordinal rather than ratio-scaled. However, Ochieng Owuor and Zumbo (2001) show that in the context of regression models, a fewer number of Likert scale points result in larger biases and that four or more Likert scale points should be used. The data we use in the PCA has been differenced from the benchmark value and transformed by an asymmetric loss function. For a full discussion of the use of Likert scale variables in PCA see Kolenikov and Angeles (2009).

15 Based on the Eigen vector of the largest Eigen value.

16 See for example Sinkey (2002) p. 140.

However, in reality there have been no bank insolvencies in China that resulted in closure, in the post-communist era.[17] The index can be interpreted as a measure of the probability of technical insolvency and used as an indicator of the riskiness of the bank. For example the correlation between the risk index defined by equation (2) and the NPL ratio of the bank in 2007 is -.8860. A higher index score indicates a safer bank which correlates significantly with a lower NPL ratio. The risk index (denoted RI-07) was therefore used as a test of the veracity of the combination of the 15 factors shown in Figure 3.

Two combinations were compared. The simplest was the un-weighted average of the 15 factors (RISKMEAN) and the relatively sophisticated measure was the largest principal component of the 15 factors that arose out of a PCA (RISKPCA).[18] While the correlation between the simple average (RISKMEAN) and the risk index (RI-07) was a mere 0.2877 and the correlation between RISKPCA and RI-07 was 0.3753, the Spearman's rank correlation was 0.0920 ($p > |t| = .7420$) and 0.6321 ($p > |t| = .0115$) respectively, suggesting that the largest principal component was a better indicator of risk practice in terms of the ranking of banks than the simple average. We concentrate our analysis using the RISKPCA measure.[19]

Similar to the construction of the risk management practice measure, two indices of risk management organisation were constructed from the transformed raw scores relating to training, staffing, recruitment and retention. The first was an unweighted average (ORGMEAN) of the transformed scores and the second was the first principal component of a PCA analysis (ORGPCA). The simple correlation between these two was 0.6579 and the Spearman's rank correlation was 0.6005 ($p > |t| = .0179$). However, there was no significant correlation between either of the two measures and an objective measure of risk or bank performance such as cost-income ratio or ROA.[20]

4. Network Data Envelopment Analysis

In this section the measures of risk practice and organisational performance are treated as inputs in a multi-stage production process of the bank in a Data Envelopment Analysis (DEA) framework to transform primary inputs of operational expenses and fixed assets into the outputs of net-interest income and non-interest income.

[17] In 2007 a number of weak city commercial banks were merged to form a single stronger bank.

[18] The correlation coefficient between RISKMEAN and RISKPCA was 0.5849 ($p > .0220$) and the Spearman's rank correlation was 0.6357 ($p > |t| = .0109$).

[19] The quantitative risk tools were combined with the 15 risk factors but the correlations and rank correlations of the resulting simple average or the largest principal component from a PCA with the risk index suggested that there was little gain in including them and were subsequently excluded in the construction of an appropriate index.

[20] Both measures were used in the empirical analysis but only the results using the PCA are reported in the next section for reasons of brevity. The results from using both were qualitatively similar.

The traditional DEA method is a linear programming method for measuring the relative efficiency of DMUs that have multiple inputs and outputs. It is a technique that has been used as a benchmarking process in evaluating the efficiency of management to transform input resources into outputs relative to 'best practice'. In the traditional DEA model, performance measurement is based on a 'black box' process (Färe and Grosskopf, 2000). Inputs are transformed into outputs but the transformation process is implicit and unknown. Indeed the advantage of DEA is that it does not impose a specific structure. However, researchers impose some structure when applying DEA to specific problems. A common structure is the two-stage DEA. The two-stage method has been applied to numerous cases. For example in the case of a bank, labour and fixed capital can be used to generate deposits, which in turn is used to generate interest earning assets. The deposits can be viewed as an intermediate output which is an intermediate input to produce interest bearing assets in the second stage of production. Recent expositions can be found in Chen and Zhu (2004), Kao and Hwang (2008), Chen, Liang and Zhu (2009) and Cook, Liang and Zhu (2009).

However, the two-stage DEA model is only one of a family of DEA models that comes under the notion of a network DEA (NDEA) framework. Färe and Grosskopf (2000) develop a general formulation of the network DEA which attempts to provide deeper structure to the 'black box' transformation of the conventional DEA. We construct a network DEA that utilises the risk and organisational indices we construct as intermediate inputs in the production process.

Hua and Bian (2008) illustrate the case of a general network DEA (NDEA) model with several separate production nodes including undesirable outputs. Assume that there are [*N*] DMUs (*n*=1,2,…*N*) and each DMU consists of [*P*] sub-DMUs (stages in production, (*p*=1,2,….*P*)). Each sub-DMU transforms inputs into outputs producing in total [*K*] external outputs $\left[y^{*}_{n,p,k}\right]$ (*k*=1,2,..*K*) and [*Q*] internal outputs $\left[\tilde{y}_{n,p,q}\right]$ (*q*=1.2….*Q*) that use [*M*] external inputs $\left[x_{n,p,m}\right]$ (*m*=1,2,…*M*) and [*R*=*Q*] internal inputs $\left[\hat{y}_{n,p,r}\right]$ (*r*=1,2,…*R*).

Denote $[x_{n,p,m}]=(x_{1,p,m},x_{2,p,m},...x_{N,p,m}),(p=1,2,.....P,m=1,2,...M)$ as the external input vector of the i[th] sub-DMU of the network DMU_j. Let the external output vector $[y^{*}_{n,p,k}]$ contain [*D*] desirable outputs $[y^{*}_{n,p,d}]$ (*d*=1,2,..*D*) and [*U*] undesirable outputs $[y^{*}_{n,p,u}]$ (*u*=1,2….*U*; *K*=*D*+*U*).

To improve relative efficiency of the network DMU, the variables $[y^{*}_{n,p,d},\hat{y}_{n,p,r},\tilde{y}_{n,p,q}]$ has to be increased while simultaneously decreasing $[x_{n,p,m},y^{*}_{n,p,u}]$. The aggregate performance measure of the network including undesirable factors can be defined as;

$$\theta_{n,p} = \frac{\sum_{p=1}^{P} \mu_p y^*_{n,p,d} - \sum_{p=1}^{P} \delta_p y^*_{n,p,u} + \sum_{p=1}^{P} v_p \tilde{y}_{n,p,q}}{\sum_{p=1}^{P} \omega_p x_{n,p,m} + \sum_{p=1}^{P} \gamma_p \hat{y}_{n,p,r}} \tag{4}$$

where $\mu_p, \delta_p, v_p, \omega_p, \gamma_p$ are respective multipliers. By the definition of the aggregate efficiency measure $\theta_{n,p}$ above, the performance measure for the p^{th} sub-DMU of the network DMU$_n$ can be represented as;

$$\theta_{n,p} = \frac{\mu_p y^*_{n,p,d} - \delta_p y^*_{n,p,u} + v_p \tilde{y}_{n,p,q}}{\omega_p x_{n,p,m} + \gamma_p \hat{y}_{n,p,r}} \tag{5}$$

A DMU is said to be efficient if its aggregate score is equal to unity. It can be shown that the aggregate performance measure $\theta_{n,p}$ is a convex combination of all sub-DMU's performance measures $\theta_{n,p}(p = 1,3,....P)$. This implies that the final efficiency score of the network DMU will *be a weighted average of the sub-DMUs.*[21]

The objective is to maximise the aggregate efficiency measure of a DMU$_0$ ($\theta_{n,0}$). Following Charnes and Cooper (1962) the non-linear programming problem becomes:

$$\begin{aligned} &Max.....\theta_{0,p} = \sum_{p=1}^{P} \mu_p y^*_{0,p,d} - \sum_{p=1}^{P} \delta_p y^*_{0,p,u} + \sum_{i=1}^{p} v_p \tilde{y}_{0,p,q} \\ &s.t. \\ &\sum_{p=1}^{P} \omega_p x_{0,p,m} + \sum_{p=1}^{P} \gamma_p \hat{y}_{0,p,r} = 1 \\ &\sum_{p=1}^{P} \mu_p y^*_{n,p,d} - \sum_{p=1}^{P} \delta_p y^*_{n,p,u} + \sum_{p=1}^{P} v_p \tilde{y}_{n,p,q} - \left(\sum_{p=1}^{P} \omega_p x_{n,p,m} + \sum_{p=1}^{P} \gamma_p \hat{y}_{n,p,r} \right) \leq 0 \end{aligned} \tag{6}$$

Solving (6) yields the score and all the input and output weights. By using the estimated weights, the efficiency scores of the sub-DMUs of the network DMU can be calculated.

Data Envelopment Analysis has been applied extensively in the banking literature and it is not the purpose of this paper to review the literature. Traditionally, the application of DEA to banking has followed one of two methods. The most popular method is known as the *intermediation approach* (Sealey and

[21] In the absence of priors these are usually set to equal values.

Lindley, 1977) which recognises the intermediation role of the bank by transforming the traditional factors of production such as labour and capital into outputs relating to stocks of earning assets. However, deposits and borrowed funds are seen as part of the intermediation process of taking in deposits and transforming them into loans. Consequently deposits are also classified as an input. The alternative method is the *production approach* that is closer to the neo-classical production function which uses the traditional factors of production of capital and labour and uses these to produce the number of accounts of loan and deposit services. A proxy measure would be final output of the bank, namely its revenue streams (Drake, 2003). Between these two approaches have been a number of studies that have treated deposits as both inputs and outputs. Demand deposits are seen as an output as the bank produces deposit related services to customers (billing, fund transfers, payments mechanism etc) while time deposits are maturity based and used as an input in the intermediation process. In a network framework, deposits can be seen as an intermediate output which is then used as an intermediate input in the production chain.

To appreciate the value added from the risk and organisational indices constructed for the sample set of banks, we examine two cases of network DEA, excluding and including the risk practice index and risk organisation index as external an internal inputs in the intermediate stage of production. The first is a three-stage network DEA that excludes the risk practice index and risk organisation index in the intermediate stage, but as China has historically had a large non-performing loan (NPL) problem, taking the lead from Berger and De Young (1997) that NPLs will affect bank efficiency, we treat NPLs as a separable bad output. The second case replicates the first case, where NPL is treated as a bad output, but including the measure of risk practice and risk organisation as internal and external intermediate inputs/outputs in the production chain.

Specifically, we conduct a three-stage network DEA with one undesirable output using the software *DEA-Solver-PRO Version 6.*[22] There are three primary inputs. These are operational costs (OC), fixed assets (FA) and deposits (DEP). Personnel cost (PERS) and other operational costs (OTHER) are intermediate outputs in the first stage of production and intermediate inputs in the second stage of production of interest costs (INTCOST) and branches (BR). Deposits (DEP) are treated as a primary input in the second stage of production. In combination with the primary and intermediate inputs in the second stage of production, non-interest earnings (NINT) are produced as a final output.[23] In stage three, INTCOST and BR are intermediate inputs to the production of interest earnings (INT). The undesirable output, non-performing loans (NPL) is treated as an undesirable output by including it as a primary input in the final stage of production.[24]

[22] The software DEA-Solver-PRO Version 6, www.saitech-inc.com was used.

[23] The implicit assumption is that fee income is largely generated in association with deposits which is dominated by households. In reality fee income will also be associated with corporate loans but to some extent this is captured by the creation of corporate deposits that match the marginal corporate loan account.

[24] This approximates the treatment of NPL as a separable bad output (Thanasoulis *et al*. 2008).

The software employs a weighted network slacks based model (NSBM) assuming non-orientation.[25] To summarise, there are 4 primary inputs (including one undesirable output), 2 primary outputs and 4 internal inputs which are also 4 internal outputs. The objective function for the DMU taken from Tone and Tsutsui (2007) is shown below.

$$\rho_0^* = \min \frac{\sum_{p=1}^{3} w_p \left[1 - \frac{1}{4} \sum_{i=1}^{4} \frac{s_{0,p,i}^{(-)}}{x_{0,p,i}} \right]}{\sum_{p=1}^{3} w_p \left[1 + \frac{1}{2} \sum_{j=1}^{2} \frac{s_{0,p,j}^{(+)}}{y_{0,p,j}} \right]}$$

$$s.t \qquad (7)$$

$$\sum_{p=1}^{3} w_p = 1$$

where $s_{0,p,i}^{-}$ is the input slack (four inputs) and $s_{0,p,j}^{+}$ is the output slack (two outputs). Efficiency at each stage of production (division) is given by equation (8) below.

$$\rho_j = \frac{1 - \frac{1}{4} \left(\sum_{i=1}^{4} \frac{s_{0,p,i}^{-}}{x_{0,p,i}} \right)}{1 + \frac{1}{2} \left(\sum_{j=1}^{2} \frac{s_{0,p,j}^{+}}{y_{0,p,j}} \right)}; (p = 1,2,3) \qquad (8)$$

The overall efficiency of the DMU is the weighted sum of the divisional (stages) efficiencies.

Case 1

The optimisation exercise is to maximise the desirable outputs and minimise the undesirable outputs within each sub-DMU. Separating the stages of the creation of balance sheet items is more consistent with the intermediation approach. Operational costs and fixed assets are used to separate personnel costs from other costs. Deposits is a primary input but enters the production chain at a stage once the primary factor inputs of OC and FA have been deployed. The combination of personnel and other costs with deposits generate interest costs – the reward to depositors and the maintenance of the branch network. Non-interest earnings are generated as a final output at the second stage of production.[26]

[25] Non-orientation was used because it can accommodate the simultaneous contraction of inputs and expansion of outputs.

[26] The summary statistics of the input and output data used in the NDEA exercises are described in Appendix 3. The constructed risk and organisational indices from the Principal Component Analysis is presented in Table 3.2

Table 2 shows the results. The network results provide a wider menu of benchmark banks at each stage for the manager to emulate. At stage 1, no bank is 100% efficient but the big-4 can use CCB as the closest to 'best practice' and the other banks can learn from CMBCL and SPAN. A number of banks are 100% efficient at stage 2, but at stage 3 only CMBCL and SPAN are on the best practice frontier.

As a test of the veracity of the network DEA method, the overall score in Table 2 is compared with return on assets (ROA) which is generally viewed as an acceptable accounting-ratio measure of profit efficiency. A Spearman's rank correlation of the score with ROA is .6643 ($p > |t| = .0069$).[27]

Case 2

Table 3 shows the implications of extending the network process to include our measures of risk practice and organisation in the production chain. This exercise utilises the measure of risk practice as a primary input in stage 3 and risk organisation as an intermediate output in stage 2 and an intermediate input in stage 3. As in case 1, in the first stage of the process, the primary inputs are used to produce PERS and OTHER. Deposits are a primary input in the first stage and NINT is a final output. In stage 2 INTCOST, BR and risk organisation (ORGPCA) are intermediate outputs and inputs to stage 3. The organisation of the risk management function acts as an intermediate input to the third stage of production in combination with branches and interest costs and the external input of risk management practice (RISKPCA). The risk management practice measure is treated as an exogenous cultural input in the production of interest earnings in the final stage. It can be argued that different banks have different risk practice cultures that have evolved from their short history. State-owned banks may have a different risk practice to joint-stock banks because of their history of directed lending to state-owned enterprises. City Commercial banks may have to deal with local government pressures that impinge on lending decisions and so on. Additionally non-performing loans are produced as a bad output in the final stage. Figure 5 provides a graphical illustration of the process.

Table 3 shows only two banks are 100% efficient overall, China Construction Bank and Shenzhen Ping An. However, ICBC and China Merchant are fully efficient in stages 2 and 3 and China Industrial is fully efficient at stage 3. It can be seen from Table 3 that the mean efficiency score is higher and the relative dispersion is lower at each stage of the production process. The inclusion of the risk management score as a primary input in the second stage of production has improved relative efficiency scores by pushing all of the banks on or closer to the frontier, but part of the reason for this is due to the dimensionality problem in linear programming.

[27] As a benchmark exercise, we used the score from a conventional 'black box' DEA with inputs OC, FA and DEP and outputs NINT and INT, under CRS, which was compared with ROA. The Spearman's rank correlation is .4257 ($p > |t| = .1136$).

Pastor *et al*. (2002) suggest a statistical test to evaluate the marginal role of an additional input (or output) in the production process as in a nested DEA model.[28] Since the DEA model applied in Table 2 is nested within the DEA model applied in Table 3, Pastor *et al*. (2002) show that the ratio of the scores from the nested DEA to the full model represents the 'efficiency contribution measure' of additional inputs. We define a given marginal improvement in efficiency from the addition of the risk management practice and risk management organisation inputs as $\bar{\theta}$ and the actual efficiency gains as $\tilde{\theta}_i$ for the i=1..15 banks. The marginal impact of the two risk indices can be evaluated as;

$$p[\tilde{\theta}_i > \bar{\theta}] > p_0 \tag{9}$$

For a given probability p_0, the test is a conventional binomial where;

$$\Gamma_i = \begin{cases} 1,...if.\tilde{\theta}_i > \bar{\theta} \\ 0..otherwise \end{cases} i = 1,2,...15$$

Table 4 shows that evaluating the efficiency contribution at various levels of efficiency gain, the contribution of the risk indices is in the region 20% - 25% at the conventional level of significance.

A further indication of the value-added is obtained by comparing the overall score from Table 3 with ROA which gives a Spearman's rank correlation of .7080 (p > | t | = .0031) compared with 0.6643 for the result shown in Table 2.

An alternative indication of the value-added of the use of the two measures in the production process can be gauged by using the overall efficiency score as an input in explaining bank profitability. The return on assets (ROA) is regressed on the NPL-ratio and the efficiency score obtained from the two cases. As a benchmark for comparison we also use the score from a standard black-box DEA with inputs OC, FA, and DEP and outputs NINT and INT under the CRS assumption. Table 5 shows the results.

Clearly the results from Table 5 can only be interpreted as indicative. Since SCORE is constructed from operational costs and revenues of the banks it is an endogenous variable. However, as an indicator it is clear that the SCORE obtained from the inclusion of the risk practice and risk organisation functions of the bank explains ROA better in terms of R-square than the scores obtained in the black-box DEA and case 1.

[28] See also Pastor *et al*. (1999)

5. Conclusion

This paper has demonstrated an innovative application of utilising qualitative data in the efficiency evaluation of firms operating in the same market. Specifically we have constructed an index of risk management practice and risk organisational practice for a sample of Chinese banks from qualitative information. Risk management practice and risk organisational practice was confined to the classic retail banking functions. The indices were constructed from scores provided by risk managers in domestic Chinese banks in responses to a semi-structured questionnaire. Scores on a Likert scale of 1-5 were translated into an index of practice from an asymmetric function that penalised downside deviations from best-practice more than up-side deviations. Best practice was defined from the interviews of four managers from two foreign banks operating in China. An aggregate score was constructed using principal components analysis.

The measures of risk management practice and risk management organisation obtained from questionnaire analysis may be used as a measure of performance however, organisation of the risk function is a management function and the risk management practice can be thought of as part of a culture of loan approval determined by a mixture of political as well as commercial interest. The organisation of the risk function measure can therefore be thought of as an internal intermediate input along with risk management practice as an external input, to produce interest earnings (as well as non-performing loans). The risk organisation and risk management measures are a link in the production chain of revenue streams in Chinese banking.

We found no significant direct relationship between the two constructed measures of risk management practice and risk management organisation and an objective measure of performance of the bank such as ROA. However, the input of these measures within a DEA network framework produced efficiency scores that explained ROA better than efficiency scores that excluded them. We have addressed the dimensionality problem in linear programming and demonstrated that the improvement in average efficiency as a result of using the two risk measures as intermediate inputs is a valid exercise. We argue that the information content of the risk management practice and risk management organisation measures is indirect and is better revealed within a network DEA framework

The risk management practice and risk management organisational indices constructed from interviews provide insight into the risk function in Chinese banks relative to best practice. But, it is the combination of the risk practice and risk organisation with the other inputs and outputs of the banks that matter for final performance. Provided that the results from the interviews of risk managers for each bank are representative of broad practice nationwide, the indices can be used as inputs in the intermediate stage of production.

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Table 1. Statistical Significance of Individual Factors

Individual Factor	Wilcoxon* (p<.05)	t(.05)*> |2.15|
X1 – Credit Record (SOE	.014*	-3.67*
X2 – Cash Flow (SOE)	.022*	-2.97*
X3 – Account profitability (SOE)	.059	-2.34*
X4 – Collateral or Guarantee (SOE)	.078	-1.91
X5 – Know Your Customer (SOE)	.006*	-4.08*
X6 – Credit Record (SME)	.022*	-3.06*
X7 – Cash Flow (SME)	.008*	-3.38*
X8 – account profitability (SME)	.227	-1.75
X9 – Collateral or Guarantee	.008*	-2.76*
X10 – Know Your Customer (SME)	.022*	-3.21*
X11 – Credit Record (Mortgage)	.036*	-2.78*
X12 – Personal Income (Consumer loan)	.170	1.66
X13 – Credit score (personal loans)	.003*	-5.7*
X14 – Net worth of borrower (personal loan)	.754	0.78
X15 – deposit account (personal loan)	.002*	-5.66*
X17 – Risk Management Training	.001*	-12.17*
X18 – Staffing levels	.002*	-3.78*
X19 – Organisation of workloads	.036*	-2.44*
X20 – Internal Recruitment	.177	0.95
X21 – External Recruitment	.001*	-6.27*
X22 – University background	.286	0.95
X23 – Foreign University Training	.530	0.56
X24 – Experience	.100	-2.0
X25 – Professional qualification	.009*	3.24*
X26 – Higher degree	.038*	2.44*
X27 – Retention Policy	.834	-0.22

Table 2. Three Stage Network with NPL as Bad Output

No.	DMU	Overall Score	Overall Rank	Division1 Score	Division1 Rank	Division2 Score	Division2 Rank	Division3 Score	Division3 Rank
1	ICB	0.5481	4	0.4943	10	0.6292	8	0.5207	3
2	GDB	0.4123	6	0.5124	9	0.5912	10	0.1333	11
3	CMBCL	0.9505	1	0.8516	2	1	1	1	1
4	ABOC	0.2547	13	0.5528	7	1	1	0.0145	14
5	CCB	0.5653	2	0.7874	3	1	1	0.1985	7
6	CMB	0.0609	14	0.749	5	0.9309	5	0.0238	13
7	HUAXIA	0.0237	15	0.2254	15	0.3835	13	0.0064	15
8	EVERBRT	0.484	5	0.5167	8	0.7806	6	0.1548	10
9	ICBC	0.5497	3	0.6367	6	1	1	0.1898	8
10	BOC	0.3817	9	0.2978	13	0.6722	7	0.1751	9
11	SPD	0.3393	11	0.2947	14	0.4388	12	0.2845	4
12	SDB	0.3242	12	0.4244	11	0.4622	11	0.0859	12
13	SPAN	0.3859	8	0.9078	1	0.1725	14	1	1
14	BOB	0.3905	7	0.3078	12	0.6085	9	0.2282	6
15	CITIC	0.3446	10	0.7709	4	0.0084	15	0.2637	5
	Average	0.401027		0.555313		0.6452		0.28528	
	Std Dev	0.219209		0.221206		0.314219		0.317234	
	Coeff Var	0.546619		0.398345		0.487011		1.11201	

Table 3. Network DEA Incorporating Risk and Organisational Input Measures

No.	DMU	Overall Score	Overall Rank	Division1 Score	Division1 Rank	Division2 Score	Division2 Rank	Division3 Score	Division3 Rank
1	ICB	0.7376	5	0.8483	4	0.5372	10	1	1
2	GDB	0.5241	10	0.5278	11	0.6033	9	0.4412	11
3	CMBCL	0.9493	4	0.8478	5	1	1	1	1
4	ABOC	0.5361	8	0.6415	9	0.6939	6	0.323	12
5	CCB	1	1	1	1	1	1	1	1
6	CMB	0.1173	14	0.5949	10	0.6918	7	0.0572	14
7	HUAXIA	0.0356	15	0.2421	15	0.3993	13	0.0178	15
8	EVERBRT	0.6816	7	0.7026	8	0.6385	8	0.7281	9
9	ICBC	0.9535	3	0.8604	3	1	1	1	1
10	BOC	0.717	6	0.2869	14	0.9608	5	0.9034	6
11	SPD	0.4637	12	0.7772	7	0.2726	14	0.8516	7
12	SDB	0.4156	13	0.4486	13	0.4798	11	0.3182	13
13	SPAN	1	1	1	1	1	1	1	1
14	BOB	0.4794	11	0.454	12	0.4787	12	0.506	10
15	CITIC	0.5309	9	0.8296	6	0.0096	15	0.7534	8
	Average	0.609447		0.67078		0.651033		0.659993	
	Std Dev	0.297394		0.240191		0.302253		0.355074	
	Coeff Var	0.487974		0.358077		0.464267		0.537997	

Table 4. Efficiency Contribution Measure

Tao (Γ_i)	Gain of 10%	Gain of 20%	Gain of 25%	Gain of 26%
1	14	13	12	10
0	1	2	3	5
p value	.000977	.00739	.0352	.302

Table 5. Dependant Variable ROA, 'P' Values in Parenthesis

	Black box DEA	Network DEA Case 1	Network DEA Case 2
Intercept	0.328 (.197)	0.704*** (.000)	0.625*** (.000)
NPL_RATIO	-.037*** (.002)	-.032*** (.005)	-.035*** (.001)
SCORE	0.911*** (.007)	0.877*** (.003)	.725*** (.000)
$\overline{R}^2$	.6378	.6755	.7803
$\hat{\sigma}$	.2040	.1931	.1589
F(2,12)	13.33	15.57	25.86

Figure 1. Lending Decision

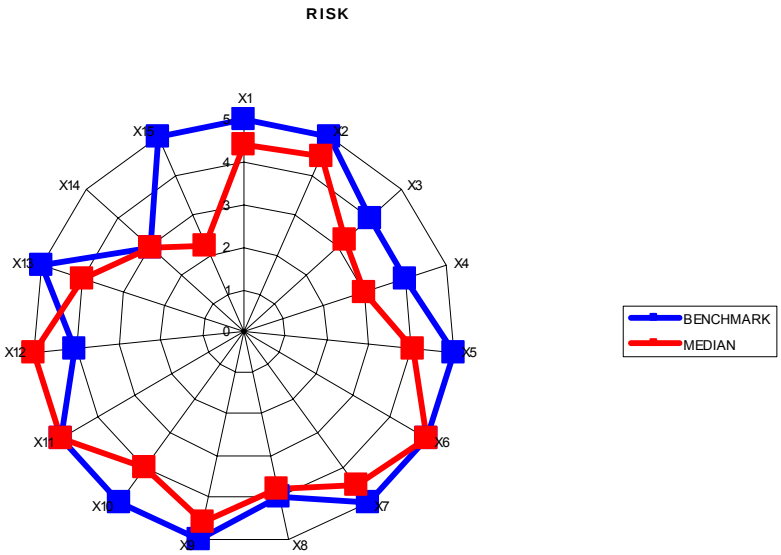


Figure 2. Risk Management Practice

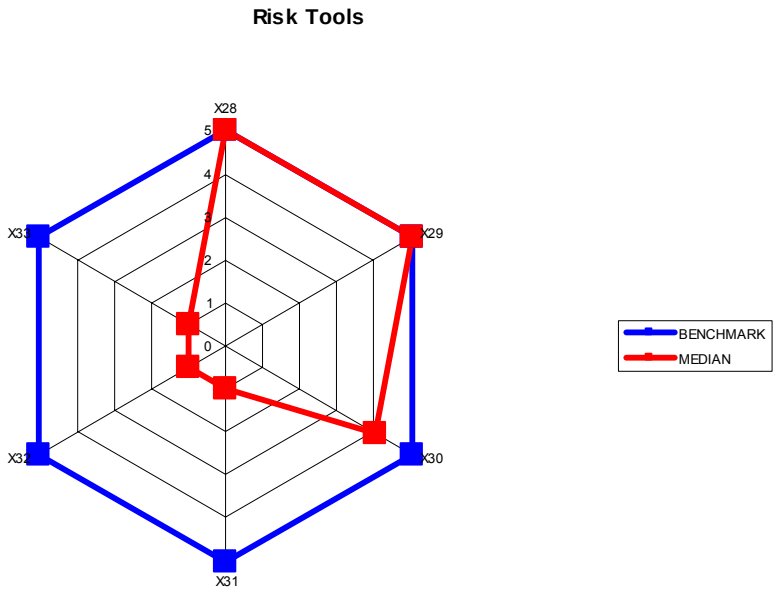


Figure 3. Risk Management Organisation

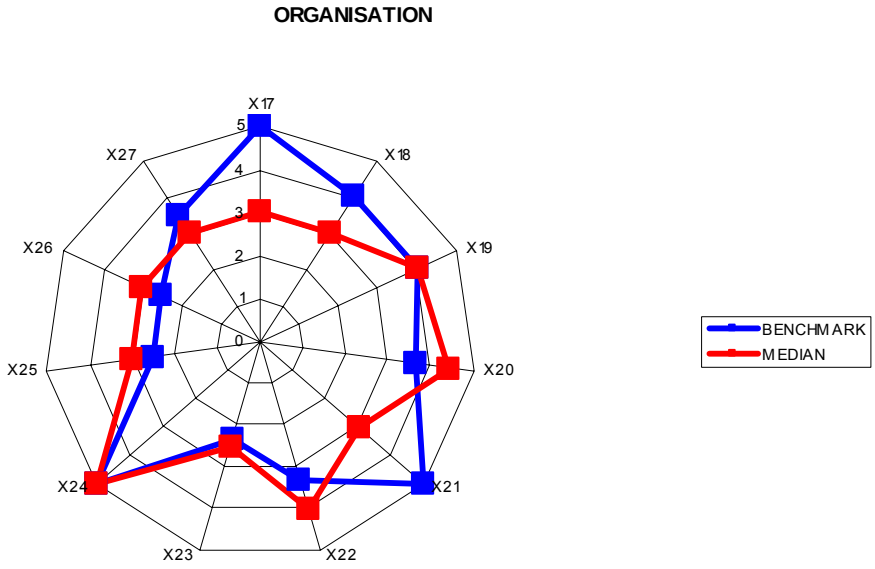


Figure 4. Relative Score Translation Function

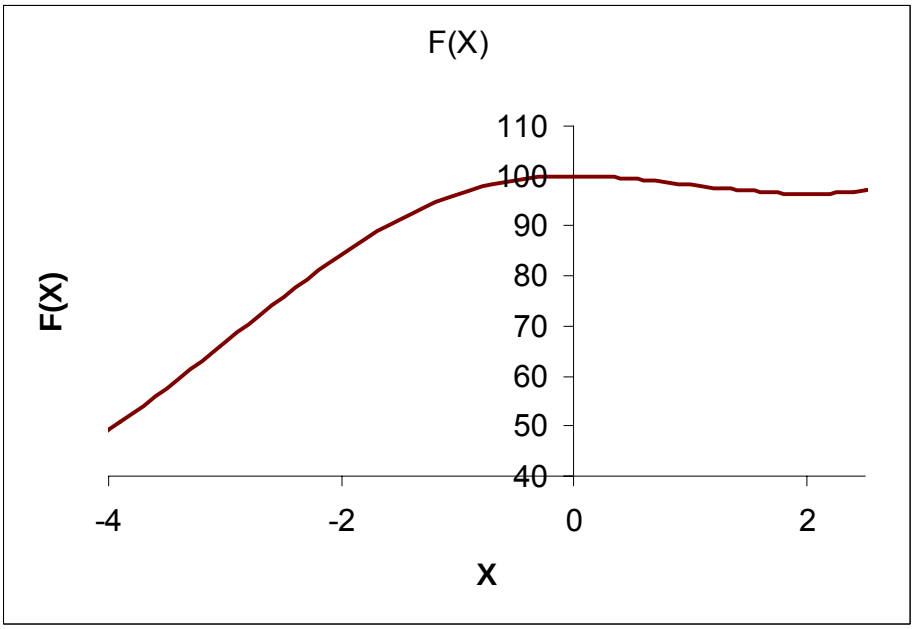
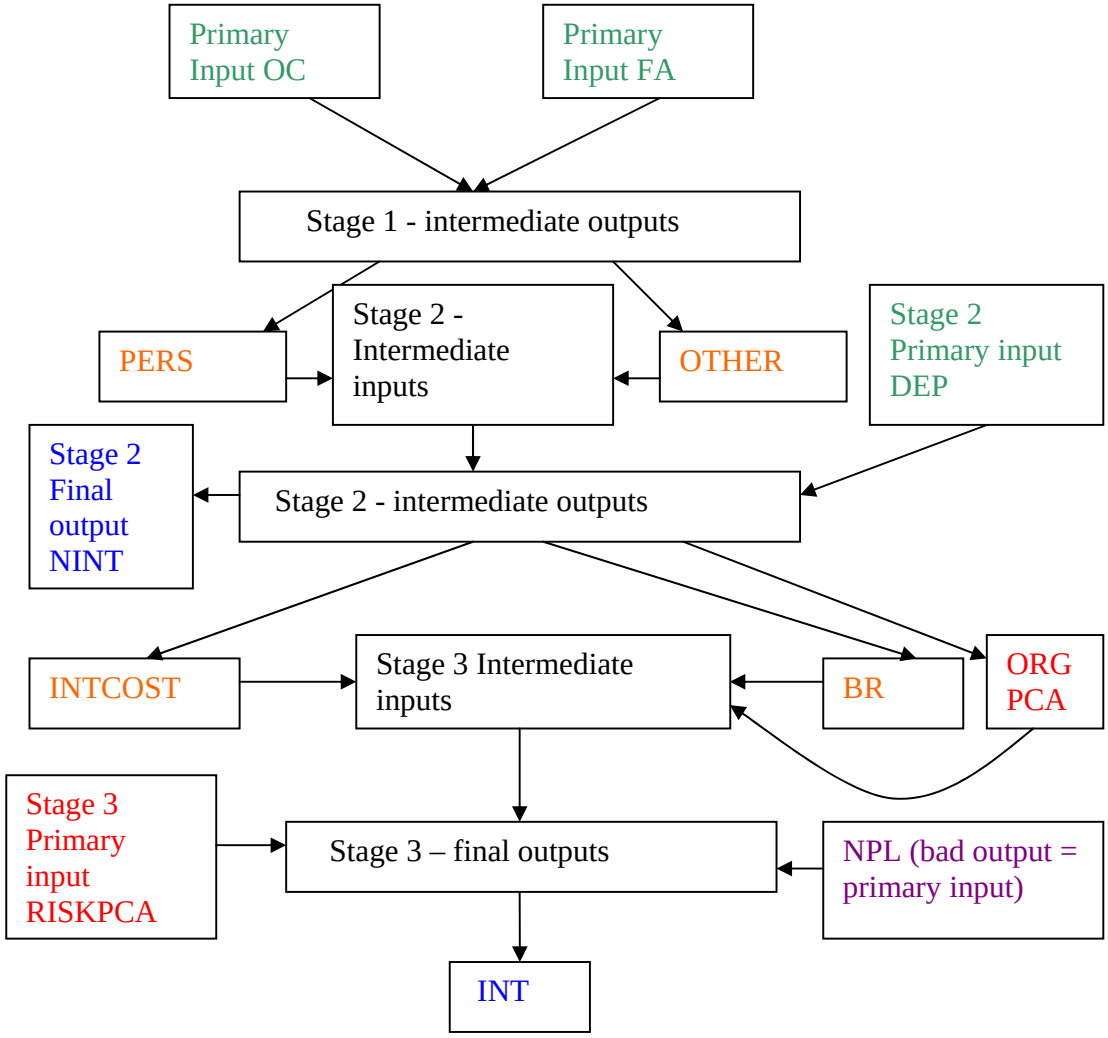


Figure 5. Three-Stage Network DEA, NPL as Bad Output and Risk Practice as External Input and Risk Organisation as Internal Input/Output



Appendix 1.

Semi-structured Interview / 半結構訪談提綱

1. Principles of Loan Approval /貸款審批原則

1 Large enterprise /大型企業

2 SMEs /中小型企業

3 Consumer loans – mortgages 消費貸款－按揭貸款

Large Enterprises /大型企業

Three main factors that determine loan approval to large enterprises;
對大型企業放貸的決定因素

a)
b)
c)

Comments 評論

Large Enterprises /大型企業

Scoring System 1 = not important, 5 = Very important
評分標準 1~5 分， 1=不重要，5 非常重要

Factor Scores 放貸決定因素得分情況

Credit Record 信用記錄	[X1]
Cash Flow 現金流量	[X2]
Account profitability (spread + fee income) 銀行收益（利息+中間業務）	[X3]
Collateral/guarantee 抵押/擔保	[X4]
Knowing the customer 對客戶認知程度	[X5]

SMEs 中小企業

Factor Scores 放貸決定因素得分情況

Credit Record	信用記錄	[X6]
Cash Flow	現金流量	[X7]
Account profitability (spread + fee income) 銀行收益（利息+中間業務）		[X8]
Collateral/guarantee	抵押/擔保	[X9]
Knowing the customer 對客戶認知程度		[X10]

Consumer Loans 消費貸款/個人貸款

Mortgages 按揭貸款

Credit Record	信用記錄	[X11]
Income	申請人收入水平	[X12]
Credit Score	申請人個人信用評分/評級	[X13]
Net worth	淨資產	[X14]
Deposit account with bank 銀行存款		[X15]

Comments 評論

2. Main reason for non-approval of loans / 拒絕放貸的主要原因

SOE /國企

.

SME / 中小企業

Private Companies / 私營企業

Mortgages / 按揭貸款

3. Loan pricing. How is interest rate used as leverage?
貸款定價。作爲定價的槓桿，利率水平是如何確定的？

Cost of funds + overheads + risk? 資金成本+ 管理費用 +風險？

Comments 評論

4. What risk management tools are used in bank operations?
貴行在經營中現使用的風險管理工具是？
Examples:

a) RAROC /風險調整後資本收益率
b) Credit scoring models / 信用評級
c) Credit committee /貸審委員會
d) Risk index /風險指標體系
e) Credit metrics – rating migration models /現代信用風險度量模型（信貸矩陣 – 信用評等轉換）
f) Stress-testing

Comments 評論

5. Incentives, Compensation, Staffing, Training, Recruitment and Retention
激勵機制、收入、員工、培訓、員工招聘和人才保留

a) Incentives/Compensation – how is compensation of the risk management team determined? 激勵/收入–風險管理隊伍員工的收入是怎樣決定的？

b) Performance evaluation 考核體系是怎樣的？

c) Training 培訓
Training of risk managers – [5] Excellent, [4] Good, [3] Adequate, [2] Inadequate, [1] Useless.
對風險管理員工的培訓評價 – [5] 非常好， [4] 好， [3] 尚可， [2] 不夠， [1] 沒用.

Score 評分 [X17]

d) Staffing levels 員工人數充足度

Risk staff 風險管理條線 [X18]

e) Organisation 組織和安排

Organisation of work flow/through-put 對工作業務量的組織和安排

Where [5] Optimal, [4] Good but no slack or flexibility, [3] Adequate but slippage and deadlines frequently not met, [2] Inadequate to meet flow of work, [1] No Team to speak off.
這裡 [5] 達到理想狀態， [4] 好，但是靈活性不夠， [3] 尚可，但是經常不能在規定的時間內完成工作， [2] 不能夠承擔工作量， [1] 沒有團隊.

Score 得分 [X19]

f) Recruitment 員工招聘

Internal recruitment 行內招聘 Score 得分 [X20]
External recruitment 行外招聘 [X21]
University training 大學教育 [X22]
Foreign university background 國外教育背景 [X23]
Experience 經驗 [X24]
Professional qualification 職業證書/資格 [X25]
Higher degree 高學歷 [X26]

g) Retention 人才留用

Score: Performance of the Bank in retaining key staff [5] Excellent, [4] Good, [3] Fair, [2] Bad, [1] No policy.
評分：銀行在保留業務骨幹方面的表現 [5] 出色， [4] 好， [3] 普通， [2] 不好， [1] 沒有政策
Score 評分 [X27]

Comments 評論

6. Auditing of loan portfolio 對信貸資產組合的檢查

How is auditing of loan portfolio done? How frequent?
如何做和頻率如何？

7. Loan Portfolio
信貸資產組合

Exclusions 禁入的行業和部門

What industries are excluded from loans?

哪些行業不予以貸款？

Which sectors are excluded from loans?

哪些經濟部門不予以貸款？

8. Weighting of Incentives versus training 激勵和培訓的權重 (%)

In evaluating the role of incentives and training in improving management performance.

在改進管理，提升業績方面，您認爲激勵機制和培訓的權重是多少？

Incentives	激勵	[ ]
Training	培訓	[ ]
Sum		[100%]

Appendix 2.

Table 2.1

Bank Number	Mnemonic	Bank Name	Number of Interviewees
1	ICB	Industrial Bank of China	1
2	GDB	Guangdong Development Bank	1
3	CMBCL	China Merchant Bank Co Ltd	2
4	ABOC	Agricultural Bank of China	1
5	CCB	China Construction Bank	1
6	CMB	China Minsheng Bank	1
7	HUAXIA	Huaxia Bank	1
8	EVERBRT	Everbright Bank of China	2
9	ICBC	Industrial and Commercial Bank of China	2
10	BOC	Bank of China	1
11	SPD	Shanghai Pudong Development Bank	1
12	SDB	Shenzhen Development Bank	1
13	SPAN	Shenzhen Ping An Bank	3
14	BOB	Bank of Beijing	1
15	CITIC	China CITIC Bank	1
Foreign Agencies			
1	Citi	Citibank (China)	2
2	HSBC	Hong Kong Shanghai Banking Corporation	1
3	BEA	Bank of East Asia (Hong Kong)	1
4	EXP	Experian (China)	1

Appendix 3.

Table 3.1 Summary Statistics of NDEA data (2007)

Variable	Mean	Standard Deviation	Minimum	Maximum
Primary Inputs				
Deposits RMB mill	2,032,930	2,553,361	133,339	7,774,462
Fixed Assets RMB mill	24,036	34,786	534	98,393
Operational costs RMB mill	26,335	33,644	1,465	93,400
Intermediate Inputs/Outputs				
Personnel costs RMB mill	14,212	18,867	849	54,899
Other costs RMB mill	12,124	14,991	617	39,223
Interest costs RMB mill	39,294	44,736	1,808	132,822
Branches	4,611	7,811	59	24,452
Bad output				
NPL	79,628	207,467	310	817,973
Final Output				
Interest earnings	92,404	119,571	738	357,287
Non-interest earnings	8,004	11,903	108	34,384

Table 3.2 Risk and Organisational Indices Based on the Largest Principal Component

DMU	RISKPCA	ORGPCA
ICB	91.53	89.14
GDB	93.00	94.95
CMBCL	92.45	94.19
ABOC	93.17	93.77
CCB	94.30	93.12
CMB	94.04	94.14
HUAXIA	95.01	91.38
EVERBRT	94.10	94.15
ICBC	93.43	94.31
BOC	86.80	93.64
SPD	93.39	95.13
SDB	93.76	94.89
SPAN	93.92	93.95
BOB	93.91	95.23
CITIC	93.68	96.51
% Variation explained	58.50	45.40