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Non-Parametric Analysis of Efficiency Gains from Bank Mergers in India

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Abstract

This paper offers an insight into the effectiveness of economic policy reforms in the Indian Banking System by examining the efficiency benefits of mergers among Scheduled Commercial Banks in India over the post-reform period 1991-92 to 2004-05. It does this by using the methodology developed by Bogetoft and Wang (2005). We also provide a metric for judging the success or failure of a merger. Overall, we find that bank mergers in the post reform period possessed considerable potential efficiency gains stemming from harmony gains. Post merger efficiency analysis of the merged bank with a control group of non-merging banks reveals an initial merger related efficiency advantage for the former that, while persistent, did not show a sustained increase thus failing to provide the merging banks with a competitive advantage vis-à-vis their non-merging counterparts. To-date there have been relatively few studies focusing on the mergers and acquisitions scenario in India and even fewer focusing on the efficiency benefits of mergers involving SCBs. This paper addresses this current weakness in the literature.

Keywords: Data Envelopment Analysis, Efficiency, Mergers, Banking, Intermediation Approach, Production Approach

JEL Classification: C14, G21, G34

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1. Introduction

Market driven business mergers have long been an integral part of the commercial history of developed economies. However, in the emerging economies this phenomenon has gained momentum relatively recently. The reasons for this are not far to seek considering that the requisite enabling environment such as economic policy liberalization, deregulation, privatization and other market reforms have been put in place only recently as compared to developed economies. Consequently, there have been numerous studies examining the motivations behind and benefits of mergers in developed economies. These studies on the impact of mergers on the efficiency of merging banks find little evidence of efficiency gains (Amel et al, 2004; Garden & Ralston, 1999; Peristiani, 1997). These studies however, are based on the US, UK and European financial institutions. While the data and research findings pertaining to bank mergers in developed economies provide valuable evidence on the effects of mergers on firm efficiency, these may not necessarily be applicable in entirety to an emerging economy such as India due to the prevalence of widely different economic and institutional conditions.

This paper offers an insight into the effectiveness of economic policy reforms in the Indian Banking System by examining the efficiency benefits of mergers among Scheduled Commercial Banks (SCBs) in India over the post-reform period 1991-92[1] to 2004-05. Using the Bogetoft and Wang (2005), model, the potential for merger gains is calculated and decomposed into technical, harmony and size efficiency components. We extend this application to evaluate post sample realisations of the potential gains. Post-merger technical efficiency is used to gauge the degree to which the potential technical efficiency gains have been realized following the completion of the merger, for up to a decade. We also provide a metric for judging the success or failure of a merger.

India is a relatively late entrant to the arena of economic liberalization as the era of significant market reforms commenced only in 1990. Hence the current merger wave in India that could justifiably be termed the first merger wave triggered by market reforms (Bhoi, 2000; Lakshminarayanan, 2005), offers an important research opportunity to assess the efficiency benefits that flow from such mergers. To-date there have been relatively few studies focusing on the

[1] The Financial year in India begins on April 1st and ends on 31st March. Consequently, the period 1991-92, for example, is henceforth referred to as 1992.

mergers and acquisitions scenario in India and even fewer focusing on the efficiency benefits of mergers involving SCBs. This study addresses this current weakness in the literature

This paper is organised into 7 sections. Section 2 provides an overview of the Indian banking system and the economic reforms initiated in 1991. A brief literature review of the mergers and acquisitions studies centred on Indian firms is presented in Section 3. Section 4 describes the methodology employed while Section 5 details the data set used. Results are presented and discussed in Section 6. Finally, Section 7 concludes.

2. The Indian Banking System and Economic Reforms

Commercial banks in India may be broadly categorised based on ownership into Public Sector Banks (PSBs), Private Banks and Foreign Banks. Together they fall under the Reserve Bank of India (RBI) classification of Scheduled Commercial Banks (SCBs)[2]. The public sector banks, which prior to reforms were wholly state owned[3], are comprised of nationalised banks and the State Bank of India and its Associates. Majority equity holding in the former is with the Government of India while the RBI holds majority equity in the latter. Private sector banks are comprised of the old private banks and the new private banks[4]. PSBs dominate the Indian Banking System accounting for over 70% of the assets of the SCBs in India (Report on Trends and Progress of Banking in India, 2005).

The financial system in India in the first decade following independence in 1947 was a liberal one. However, the first of two waves of nationalization occurred in 1969, and heralded a new system of tight regulatory control. The primary features of this system were high reserve ratios and an administered interest rate regime in which regulations dictated deposit and lending rates. Furthermore, certain economic sectors were designated Priority Sectors and banks were required to lend up to 40% of their total credit to these sectors.

[2] PSBs, Private and Foreign Banks are known as Scheduled Commercial Banks as they are included in the Second Schedule of the Reserve Bank of India Act, 1934. A fourth category of banks known as Regional Rural Banks (RRBs) is also included in the SCB category. RRBs are specialised financial institutions that concentrate on provision of credit services in the rural sector. Due to their specialised operations profile, these banks are excluded from this study.

[3] Following the introduction of economic reforms in 1990-91, Government ownership of PSBs was diluted and PSBs were allowed to raise up to 49% of their equity through the capital market.

[4] New private sector banks are private banks that were established in the post reform period.

These policies were introduced in an effort to facilitate the spread of banking services to rural areas, mobilize savings, and channel credit towards the development of weaker but vital sectors of the economy such as the agricultural sector and the small-scale industry (Bhattacharya et al, 1997). An equitable distribution of credit was thus the basis of the policies initiated. To this end, priority sectors were created and banks were required to meet concessional lending targets to these sectors.

As a result of the aforementioned policies, the PSBs began to dominate the Indian Banking System. Indeed, prior to economic liberalization in 1991, the PSBs accounted for 90.8% of aggregate deposits of SCBs. The financial system came to be characterised by low profitability, high levels of Non-Performing Assets (NPAs), a low capital base and high levels of operational inefficiency (Arun & Turner, 2002). As noted by Mistry (1995), while the banking system was successful in mobilizing savings, it failed in efficient resource allocation.

The reasons for this failure are not far to seek. In a market-oriented framework, banks would only undertake those loans which met stringent credit risk standards. Further, having made the loan, banks would then have an incentive to monitor those loans to ensure that borrowers comply with the loan terms and lower the risk of adverse selection and moral hazard. In the case of the Indian Banking System, however, due to directed lending policies in the form of the priority sector lending and pre-emption of funds through the high reserve requirements, the business of banking came to be characterized by the sole pursuit of quantitative target attainment as specified by regulatory diktats. Innovation and expansion of service range was sidelined in favour of the minimalist approach of passive compliance with regulation imposed objectives and targets. In addition, in such a tightly administered system, banks lost the incentive to adopt appropriate risk management systems. Thus, scant regard to fundamental financial performance coupled with a rigid desire to meet quantitative objectives led to the permeation of operational inefficiency in the banking system triggering the need for economic reforms in 1991 to improve its strength, profitability, and efficiency.

The recommendations of the Committee on Financial System and the Committee on Banking Sector Reforms (Narasimham Committees I and II) formed the foundations of the economic reforms undertaken. Policy changes introduced as part of the reforms package included a deregulation of interest rate controls, introduction of prudential norms and reporting standards,

enhancement of the competitive landscape of the banking system through relaxed entry restrictions for foreign banks and a gradual reduction in equity holding of the State in PSBs.

The economic reforms brought about a comprehensive change in the competitive landscape of the Indian Banking System forcing many of the incumbent banks to adopt mergers and acquisitions with the objective of restructuring themselves in order to enhance their efficiency, profitability, and competitive strength. In addition, the Government introduced policy initiatives aimed at deregulation and encouragement of mergers with a view to increasing the size, profitability, and financial strength of Indian Banks thereby enhancing their capability to compete globally. This climate of relaxed merger regulations fostered an increase in the number of merger deals among Indian firms (Beena, 2000). In light of this, the dearth of empirical studies examining efficiency benefits flowing from these mergers is surprising. The following section provides a review of the few such studies that comprise this literature on Indian bank mergers.

3. Mergers : The Indian Experience

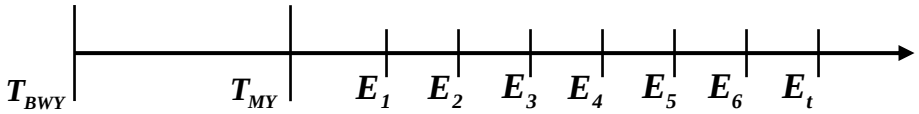
The phenomenon of mergers and acquisitions among Indian banks is not restricted to the post reform era of the Indian Banking System. Between 1961- 2004, there have been 71 mergers among various banks in India (Lakshminarayanan, 2005). Of these, 55 mergers occurred during the pre-reform period of 1960-1990. It is important to note that many mergers during the pre-reform period were instituted by the Government in an effort to restructure ailing banking units. Market driven mergers, which are on a gradual rise, are thus, outcomes of the post reform period, driven by the change in the competitive landscape of the Indian banking system which forced many of the incumbent banks to restructure themselves and boost their efficiency in an attempt to ensure long-term profitability and survival.

The current favourable environment for mergers is highlighted in a study by Beena (2004) which finds evidence of a rising trend in the number of mergers in the Indian corporate sector since the introduction of economic reforms. However, this study focuses on the private corporate sector and uses accounting ratios to assess pre- and post merger performance. The author analysed 115 domestic and foreign mergers over the period 1995-2000. Following the merger, it was found that, both domestic and foreign owned acquiring firms exhibited declining rates of return.

Beena (2000), further studies the trends of mergers in India over a longer period spanning 1973-1995. Examining the number of mergers and the industry of the merger prior to reforms, she finds that most mergers were among manufacturing industry firms although the number of mergers in non-manufacturing industries did show a gradual rise. Kumar (2000), corroborates this finding and further documents a rise in the share of the services sector in M&As by 21% over the period 1994-2000. The mergers were also between firms under related management thus pointing to the dominance of horizontal mergers. In fact, of the 256 mergers the author studied, only three were vertical. The involvement of foreign firms in mergers began in 1992 and out of the 45 cases, studied; foreign owned firms were involved in 22.22% of the mergers. This is explained in terms of relaxation of restrictions on the operations of foreign firms. However, Indian owned firms continued to dominate the merger cases over the study horizon.

4. Methodology

Using the Bogetoft and Wang (2005), Data Envelopment Analysis (DEA) model, the potential for merger gains is calculated and decomposed into technical, harmony and size efficiency components. We extend this application to evaluate post sample realisations of the potential gains. Post merger technical efficiency, derived using the DEA model developed by Banker, Charnes and Cooper (1984) (henceforth, BCC-DEA), is used to gauge the degree to which the potential technical efficiency gains have been captured following the completion of the merger for up to a decade. We thus work with the following timeline:



Post Merger Years

where:

T_{BWY} → *Year immediately preceding actual merger year, when the Bogetoft & Wang Model is used to calculate potential efficiency gains*

T_{MY} → *Year the merger actually occurred*

E_t → *Efficiency in post merger year t*

The Bogetoft and Wang, 2005, model takes advantage of the concept of output super-additivity by aggregating the outputs and inputs of the parent entities to form the merged firm. By then calculating the maximum proportional expansion of the aggregated output given the aggregated input, a measure of the potential overall efficiency gain is obtained. A measure greater than unity indicates gains from the merger as the merged entity has the potential to produce greater aggregated outputs using the aggregated inputs.

Assume a total of ***N*** firms using a vector of **x** inputs, such that $\boldsymbol{x} \in \boldsymbol{R}_{+}^{\boldsymbol{m}}$, to produce **y** outputs, such that $\boldsymbol{y} \in \boldsymbol{R}_{+}^{\boldsymbol{I}}$. The production set T(x, y) can hence be defined as, $T(x, y) = \{ (x, y) : x$ can produce y$\}$. We assume the following properties for the production set:

1. Convexity: (x, y) and $(x', y') \in T \Rightarrow \mu\ (x, y) + (1-\mu)\ (x', y') \in T,\ \mu \in [0,1]$
2. Strong Disposability: $(x, y) \in T \Rightarrow (x', y') \in T$ where $x' \geq x,\ y' \leq y$
3. Returns to Scale:
   i. *Constant Returns to Scale (CRS)* : $(x, y) \in T \Rightarrow k(x, y) \in T, k \geq 0$
   ii. *Increasing Returns to Scale (IRS)* : $(x, y) \in T \Rightarrow k(x, y) \in T, k \geq 1$
   iii. *Decreasing Returns to Scale (DRS)* : $(x, y) \in T \Rightarrow k(x, y) \in T, 0 \leq k \leq 1$

Using the above, a Piecewise Linear Representation (PLR) of the production set is defined as:

$$\mathbf{T^{PLR}(x,y) = \left\{ (x,y) : \sum_{j=1}^{N} \lambda_j x_j \leq x\ ,\ \sum_{j=1}^{N} \lambda_j y_j \geq y\ ,\ (\lambda_1,...,\lambda_N) \in S \right\}}$$

where: set S defines the returns to scale properties as follows:

$$\mathbf{S = \begin{Bmatrix} \lambda_1,...,\lambda_N : \lambda_j \geq 0 & \forall j & : CRS \\ \lambda_1,...,\lambda_N : \Sigma\lambda_j = 1, \lambda_j \geq 0 & & : VRS \\ \lambda_1,...,\lambda_N : \Sigma\lambda_j \leq 1, \lambda_j \geq 0 & & : NIRS \end{Bmatrix}}$$

Now, assume that ***J*** out of the ***N*** firms merged at time $\boldsymbol{T_{MY}}$. Within this merged group, these ***J*** firms are re-labelled ***k = 1…J***. The merged firm is now constructed in period $\boldsymbol{T_{BWY}}$ by

aggregating the inputs and outputs of the parent firms. The merged firm, at period T_{BWY} , thus has the following inputs and outputs:

$$\tilde{x}_i^J = \sum_{k=1}^{k=J} x_{ik} , \qquad i = 1 \ldots m \qquad [1]$$

$$\tilde{y}_r^J = \sum_{k=1}^{k=J} y_{rk} , \qquad r = 1 \ldots l \qquad [2]$$

Given the above, the output oriented potential overall merger efficiency gain (OE) is calculated using the following output-oriented program[5]:

$$F^J = max \left\{ F \left| \begin{array}{ll} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le \tilde{x}_i^J , & \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge F\tilde{y}_r^J , \quad \lambda_j \ge 0 \\ \forall\ i = 1 \ldots m , & \forall r = 1 \ldots l \end{array} \right. \right\} \qquad [3]$$

The CRS assumption is employed for this stage of the analysis, as the current merger wave in India is the first market driven merger wave in contrast to pre-reform mergers which were instigated by the Central Bank in order to rescue financially distressed banks. These post reform mergers can thus be viewed as adjustments by the market participants towards long-run optimal scale and efficiency. While we thus concentrate on results obtained under the CRS assumption, we also employ VRS to check for program infeasibility[6]. The merger would be advantageous to the bank if $F^J > 1$ as it would then imply that the firm can produce a greater amount of aggregate outputs using the same aggregate input quantity. Holding aggregate input constant, $F^J \le 1$ would lead to a post merger decline in the aggregate output thereby signalling that the merger is disadvantageous.

Having calculated the overall efficiency gains potential, Bogetoft and Wang identify the following decomposition:

$$\mathbf{OE = TE * HE * SE} \qquad [4]$$

[5] Please refer Section 5 for an explanation of the choice of DEA model orientation.

[6] To conserve on space, results of this is not presented. They can however, be obtained on request from the authors.

To calculate the technical efficiency gains (TE), a within merger group analysis is performed by first calculating the technical efficiencies of only those banks that were involved in the merger. This allows for the outputs of the parent entities to be expanded onto the within-merger group frontier. Having done so the (adjusted) overall efficiency is re-computed and the technical efficiency component is isolated. For this stage of the analysis, the CRS assumption may be less appropriate since specific individual mergers may have a more restricted range of adjustments possibilities. By restricting within-merger group technical efficiency gains to a VRS assumption and therefore concentrating only on pure technical efficiency improvements within the merger group, a larger share of the gains decomposition is allocated to the other components. We thus use the following BCC-DEA model for the within merger group analysis:

$$F^{o} = max\left\{ F \left| \begin{array}{lll} \sum_{k=1}^{k=J} \lambda_k x_{ik} \le x_{io}, & \sum_{k=1}^{k=J} \lambda_k y_{rk} \ge F y_{ro}, & \sum_{k=1}^{k=J} \lambda_k = 1, \\ \lambda_k \ge 0, & \forall i = 1 \ldots m, o \in J, & \forall r = 1 \ldots l \end{array} \right. \right\} \qquad [5]$$

This allows the merger partners' outputs to be adjusted to their optimal levels in accordance with their within-merger group efficiency scores. The adjustment is carried out in the following manner:

$$\tilde{Ey}_r^J = \sum_{k=1}^{k=J} F^k y_{rk} \ , \qquad k = o = 1 \ldots J, r = 1 \ldots l \qquad [6]$$

Since, we are examining actual merger cases, which involved two merging banks, the use of only the parties to the merger in this stage of the analysis would result in their continually being represented as 100% efficient. Thus, in order to better capture their true technical efficiency, banks similar to the target bank were included in this stage of the calculation. These banks were identified using their Return on Assets ratio, i.e., all banks in the same percentile as the target bank were included in the within merger group, as in theory, any of these banks could have been a target for the merger.

Using the adjusted output levels, the (adjusted) overall efficiency is re-computed using the following program:

$$F^{*J} = max\left\{ F \left| \begin{array}{ll} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le \left(\tilde{x}_i^J\right), & \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge F\left(\tilde{Ey}_r^J\right), \quad \lambda_j \ge 0, \\ \forall \ i = 1 \ldots m, & \forall \ r = 1 \ldots l \end{array} \right. \right\} \qquad [7]$$

The technical efficiency component of the decomposition is then computed as follows:

$$TE^J = F^J / F^{*J} \qquad [8]$$

We now turn to capturing the harmony gains effect (HE). Harmony gains indicate the gains from harmonising the output mix of the merged entity, i.e., the degree to which the integration of various output mixes complements the efficiency of the merged entity. Harmony gains stem from the potential that the merger may allow the firm to fine tune its production process by enabling it to adjust, i.e., harmonise, its output mix. For example, rather than carving a niche market for itself, the merged entity may be able to capture more efficiency gains by adjusting its output range to more closely resemble that of its competitors.

The Bogetoft and Wang model captures this effect by measuring how much the average output could have been expanded by using a given level of average input. This is done using the following program:

$$H^J = max\left\{ H \left| \begin{array}{ll} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le \left[\left(\tilde{x}_i^J\right)/J\right], & \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge H\left[E\tilde{y}_r^J / J\right], \quad \lambda_j \ge 0, \\ \forall i = 1 \ldots m, & \forall r = 1 \ldots l \end{array} \right. \right\} \qquad [9]$$

An H^J value greater than unity is evidence of potential harmony gains while a value lower than unity implies that the cost of harmonising the output mixes is high and therefore will erode the potential efficiency gains form the merger.

Having calculated technical and harmony gains, any remaining efficiency stems from changes in the scale of the organisation and is calculated as scale efficiency (SE). Consequently, SE gains are treated as a residual component of the decomposition and would allow the merged entity to take advantage of any returns to scale following the merger. The following program is used to capture this effect:

$$S^J = max\left\{ S \left| \begin{array}{ll} \sum_{J=1}^{J=N} \lambda_j x_{ij} \le \left(\tilde{x}_i^J\right), & \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge S\ \left[H^J E\tilde{y}_r^J\right], \quad \lambda_j \ge 0, \\ \forall i = 1 \ldots m, & \forall r = 1 \ldots l \end{array} \right. \right\} \qquad [10]$$

The Bogetoft and Wang model was applied to the year immediately preceding the merger year. In cases, where unavailability of data precluded such analysis, the nearest year for which data

was available was used. The year of the merger, itself, period T_{MY} , was not used due to the impact of adjustment costs.

Having established the potential for gains from the merger, the extent to which such gains are realised is examined using the BCC-DEA model. This is done by applying the model to the post merger sample for each of the post merger years. The post merger sample, Q, is constructed as the difference between the total number of banks in the sample and the number of banks lost due to the merger(s) in period T_{BY} . The number of new market entrants is added to this and the number of banks exiting the market is deducted over the post merger time horizon. Thus:

$$Q = N - G - Ex + En \qquad [11]$$

where:

N = *total number of Banks in* T_{BY}

G = *total number of banks lost due to the merger in* T_{BY}

Ex = *number of firms exiting the market*

En = *number of new entrants in the market*

The post merger efficiency of the Merged Bank (MB) is then calculated using the following BCC-DEA (VRS)[7] program:

$$\theta^{MB} = max\left\{ \theta \left| \begin{array}{ll} \sum_{p=1}^{p=Q} \lambda_p x_{ip} \le x_{is}, & \sum_{p=1}^{p=Q} \lambda_p y_{rp} \ge \theta y_{rs}, \\ \sum_{p=1}^{p=Q} \lambda_p = 1, & \lambda_p \ge 0, \\ \forall i = 1 \ldots m, & \forall r = 1 \ldots l, \\ \forall p = 1 \ldots s \ldots Q & \end{array} \right. \right\} \qquad [12]$$

However, care must be taken in the post merger efficiency analysis as the BCC-DEA model provides an indication only of the technical efficiency of the banks. Thus, the post merger efficiencies can only be compared to the technical efficiency component of the overall potential merger gains. We justify our choice of the BCC model because while the mergers do represent a

[7] Assuming convexity of the production possibility set and free disposability of inputs and outputs, the VRS model selects the smallest of the various production possibility sets.

move towards the long-run optimal scale for the banks, this movement is a gradual one thereby restricting banks to lie within the VRS convex hull of observations rather in the larger CRS convex cone. Therefore, post merger comparisons using the BCC-DEA model would be more appropriate.

A Kolmogorov-Smirnov[8] test was also conducted using the post merger efficiency scores of the entire sample (merged banks and control groups) for each post merger period and under both input-output models to confirm the presence of scale inefficiency. The null and alternate hypotheses were:

H_o : No significant differences in ln efficiency scores under the VRS and CRS models, i.e., there is no evidence of scale inefficiency

H_1 : Scale inefficiency is found to be prevalent among the sample banks

To analyse the impact of the merger on the efficiency of the merged entities, we compare their post merger efficiency scores in three ways. The first, using the benchmark of the Bogetoft & Wang model, i.e., the potential technical efficiency gains. In this case, a bank's post merger technical efficiency in each of the post merger years is compared to the potential technical efficiency gain. With enhanced efficiency being one of the stated objectives and motivations of the mergers, this analysis offers a direct avenue to assess the degree to which this goal has indeed been attained. This is because the Bogetoft and Wang model offers a quantitative assessment of the existence and magnitude of any potential merger related efficiency gains and comparing this with the actual post merger efficiency of the banks offers an insight into the degree to which the former have been realized. Accordingly, the higher the post merger TE of the merged bank, the greater the degree to which it was able to capture the potential TE gains as predicted by the Bogetoft & Wang model.

In addition to analysing the extent to which the potential gains are realized, we are also interested in the degree to which the merger was advantageous to the bank relative to its non-

[8] The Kolmogorov-Smirnov D-Statistic is calculated as the maximum vertical distance between the observed cumulative distributions of the efficiency scores under the two input-output models, i.e.,

$$D = \max \left| F^{G_1}\left(\ln \hat{\theta}_j\right) - F^{G_2}\left(\ln \hat{\theta}_j\right) \right|$$

A high D value and, consequently, a low p-value would indicate the presence of significant differences in efficiencies between the two groups. The test can be carried out using efficiency scores directly and would provide equivalent results.

merging counterparts. This is because, while the bank may have failed to fully capture its TE potential, it may still have realized sufficient efficiency gains to attain a competitive advantage relative to its non-merging competitors. This brings us to our second analysis, viz., a comparison of the post merger technical efficiency of the merged bank with the average technical efficiency of a control group of non-merging banks. We henceforth refer to this as an analysis of the TE Level of the bank. To perform the analysis, the post merger TE of the merged bank in a particular year was compared with the average TE of the control group in the same year. For example, the TE of a bank two years after its merger in 1998 is compared with the average TE of the control group in 2000.

We construct our control group for this analysis to comprise those banks which did not engage in any mergers over the study period. The composition of this control group varied over the time studied due to the entry and exit of banks. A dynamic control group such as this is preferred given the nature of the mergers. Six of the mergers analysed were initiated by the Central Bank in a bid to rescue an ailing bank. Part of the distress may be linked to the influx of new private and foreign banks with more efficient and streamlined operations. Excluding these banks from the sample would thus lead to an incorrect estimation of both the potential gains and the actual post merger efficiency of the merged bank. Moreover, the post reform period was characterised by a relaxation of regulations on the entry of foreign banks and the establishment of new private sector banks. The market driven mergers may thus have been undertaken in anticipation of or in reaction to the entry of new banks. Excluding these banks from the analysis in order to maintain an unchanging control group would thus lead to incorrect estimations of efficiency for the merged banks.

A Mann-Whitney test of the efficiencies between the post merger TE of the merged banks and the control group is used to check if the merger had a significant impact on the efficiency of the merged banks and if so, in what direction, i.e., were the efficiencies of the merged banks higher than that of the control group?

The Mann-Whitney test examines if two independently drawn samples originated from the same population. In doing so, it allows for the investigation into the presence of a treatment effect by examining the shift in location of the mean or median (Hollander and Wolfe, 1999). In the context of our study, this test allows us to investigate if the merger led to significantly different and higher efficiency scores for the merged banks vis-à-vis the control group. The null, alternative, and directional alternative hypotheses are as follows:

H_0 : No significant differences in the TE Levels of the merged banks and the control group

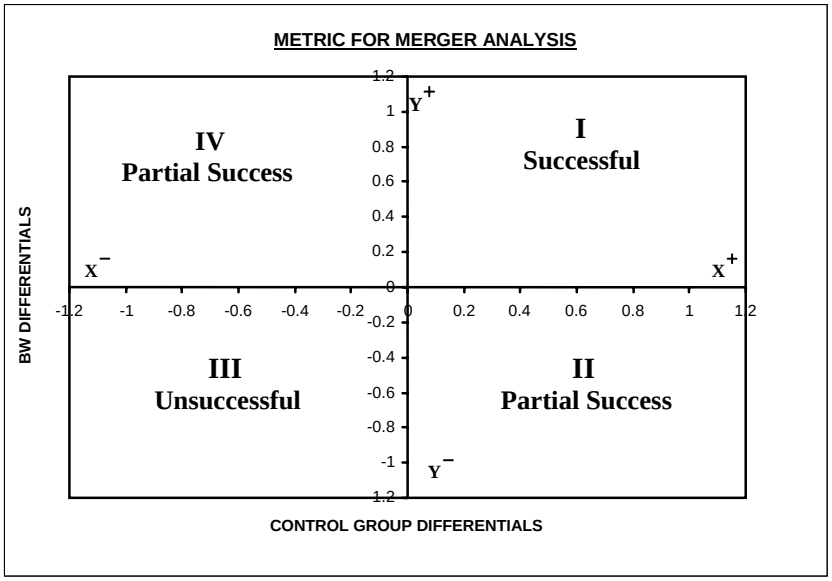
H_1 : The TE Level of the merged banks are significantly different from those of the control group

H_2 : The TE Levels of the merged banks are higher than those of the control group

If the merger is found to enhance the efficiency of the merged bank, it may encourage other competitors to engage in mergers themselves in order to reap similar gains. The analysis of the TE Level also has important policy implications for the Indian case where mergers were often instituted at the behest of the Central Bank in order to rescue a financially distressed bank. If the post merger technical efficiency of the acquiring bank registers a declining trend, it would indicate that this policy, while offering a quick solution that protected the depositors, in the long run, weakened the positions of stronger banks in the system.

The combination of this TE Level analysis and that with respect to the Bogetoft and Wang benchmark provides an interesting metric for establishing the success / failure a merger. To start with, for a bank that (a) realizes the efficiency potential as indicated by the Bogetoft and Wang analysis and (b) displays a consistently higher efficiency level than its non-merging counterparts, the merger can be considered a success. On the other hand, a merger that fails to achieve its efficiency potential under the Bogetoft and Wang analysis and, is further found to have lower post merger efficiency than the non-merging control group, can be termed as clearly unsuccessful. A merger that partially attains its efficiency potential and shows higher post merger efficiency than the non-merging banks can be termed a partial success, as would a merger that successfully realizes its potential efficiency but exhibits lower post merger efficiency levels than the control group. The figure below presents this metric for judging merger success / failure:

Figure 1. Merger Metric Using BW & CG Differentials



In the above figure, the BW Differentials refer to the difference between the per annum post merger technical efficiency of the merged bank and the Bogetoft & Wang potential technical efficiency for the merger. The Control Group Differentials are calculated as the difference between the per annum post merger technical efficiency of the merged bank and the per annum average technical efficiency of the control group. Mergers whose technical efficiency differentials evolve and congregate in Quadrant I are considered a success as they meet the dual criteria of possessing technical efficiencies that equal or exceed the BW potential[9] and exceed that of their non-merging counterparts. Those mergers that fall in Quadrant II show a higher efficiency score relative to the control group. However, they fail to meet the BW potential. Thus, while the merger allowed the bank to become more efficient than its non-merging counterparts, there remained scope for further efficiency gains as shown by the shortfall with the BW potential. These mergers are thus partially successful. In Quadrant III, the mergers failed to attain their technical efficiency potential and showed lower post merger technical efficiencies than the non-merging banks. These banks would

[9] The Bogetoft & Wang model is one of many potential merger blueprints. Therefore, an actual merger may employ a structure that is different from that assumed in the Bogetoft & Wang model. The model in this sense provides a base line indication of the potential gains emanating from the merger. A deal organized along different lines, on the other hand, may be able to capture more / less efficiency gains than those indicated by the Bogetoft & Wang model. Consequently, an efficiency differential equalling zero indicates that the merger successfully realized the potential gain as indicated by the Bogetoft and Wang model. A positive differential would indicate that the merger related gain was higher than that indicated by the Bogetoft & Wang model.

have been better off without the merger as it failed to provide any advantage to the parent banks. These mergers are thus unsuccessful. In the final quadrant, Quadrant IV, the mergers were partially successful as despite their efficiency shortfall compared to the control group, they still showed a positive differential relative to their BW potential. Possible reasons for this could be (a) the overall potential gains may be small to begin with thereby enabling the bank to fully capture this but not allowing it to out-perform the control group or (b) the Bogetoft & Wang model may not be capturing all the gains as it represents only one of many potential blueprints for the merger. This metric is applied to those mergers that showed significantly different efficiency levels vis-à-vis the control group.

An initial post merger efficiency gain as indicated by the TE Level can also be sustained and / or augmented in the post merger years thereby allowing the bank to cement its competitive edge over its peers. An examination of the efficiency change relative to a base year would isolate this trend and provide an indication of the persistence of this efficiency advantage. This represents our final analysis wherein we examine this efficiency change (henceforth, TE Change) of the merged banks vis-à-vis the control group from a base year. For example, we compare a bank which, in two years following its merger, improved its TE by 20% to the control group which over the same two years registered a 10% rise in its TE. In this case, an analysis of the TE Change would indicate that the initial efficiency gains from the merger were sustained and improved upon in the post merger years. The Mann-Whitney test is employed to determine if the TE Change of the merged banks was significantly different from that of the control group. The null, alternative and directional alternative hypothesis are as follows:

H_0 : No significant differences in TE Change between merged banks and control group

H_1 : The TE Change of merged banks significantly differs from that of the control group

H_2 : The TE Change of merged banks exceeds that of the control group

We use the first post merger year as our base year for this analysis. As mentioned earlier, the mergers represent a move towards the optimal industry structure at the constant returns to scale level of operations. However, since immediately post merger this would be a gradual shift, and as

such, a slow adjustment process, the VRS is more appropriate as it involves a more restricted set of possibilities. However, it is noted that this will result in higher post merger technical efficiency scores for the merged group than would be the case under the CRS assumption. The TE Change is calculated as the technical efficiency of the merged bank less the average technical efficiency of the control group.

5. Data

Data on all SCBs spanning the period 1991-92 to 2004-05 was collected from the Reserve Bank of India's Database on the Indian Economy. A list of mergers that took place in the post reform period was obtained from Lakshminarayanan (2005), and is reproduced in Table 2. Among the mergers, those corresponding to serial numbers two, four, and six were not included in this study due to unavailability of data. The merger between Global Trust Bank and Oriental Bank of Commerce, corresponding to serial number eleven, was excluded due to an insufficient number of post merger years.

The choice of input-output specification is an issue of considerable debate in the efficiency studies' literature. Broadly, the specifications can be classified into the production and intermediation approaches. The difference in the two approaches lies in their definition of what a bank does. Viewed as a producer of services, the production approach would be more appropriate. These services are related to both the deposit and the loan accounts. Thus, the number of accounts or the number of transactions associated with each of these accounts are taken as outputs and labour and capital are considered the inputs. On the other hand, when viewed as a financial intermediary, the intermediation approach is more appropriate. Under this approach, the bank is viewed as a financial intermediary transferring funds between surplus saving units and deficit spending units (Heffernan, 2000). Banks accept deposits and then use them to make loans and investments. Under this method therefore, deposits are considered an input used to produce outputs that encompass the value of loans and investments of the bank. The debate, thus, settles on the treatment of deposits- are they inputs or outputs? (Berger & Humphrey, 1997, Sealey and Lindley, 1977).

In this paper, we apply both input-output specification models. The reforms heralded the shift from a regime where quantitative goal attainment was the order of the day to one where operational efficiency and profitability dictated long-run survival. However, given the gradual pace

of the reforms, banks continued to operate with the dual objectives of maintaining profitability and meeting regulatory requirements geared towards socio-economic development. The application of both the production and intermediation approaches would help capture the degree to which banks efficiently perform on both these fronts. Thus, the input-output variables used are as follows:

Table 1: Input-Output Specification

MODEL	INPUTS	OUTPUTS
Model 1 (Production Approach)	**Borrowings, Fixed Assets, Other Assets**	**Deposits, Advances, Investments**
Model 2 (Intermediation Approach)	**Borrowings, Fixed Assets, Other Assets, Deposits**	**Advances, Investments**

The individual components of the input and output variables are listed in Table 3.

The Kolmogorov-Smirnov test is used to examine the impact, of the input-output specification adopted on the estimated efficiency scores. Following Banker and Natarajan (2004), the test is carried out using ln efficiency scores. The null and alternate hypotheses are:

H_o : ln efficiency is insensitive to input-output specification model used and thus consistent across input-output models

H_1 : ln Efficiency is sensitive to the input-output specification adopted

The Wholesale Price Index (WPI), which is used by the Central Bank in its framing of the Monetary Policy, the Government in its framing of the Fiscal Policy and various other Government agencies, was used to deflate nominal input and output values into real values. The WPI, has the added advantage of greater accuracy by virtue of it being updated and reported on a weekly basis.

Over the period analysed, Indian banks had less freedom to control costs (Ram Mohan and Ray, 2004). They were also required to meet targets linked to credit disbursement, albeit to a lower target level than under the pre-reform period thereby allowing the banks relatively greater autonomy in their operations, particularly on the output side. This, in conjunction with the reduced government support, particularly for PSBs and the influx of foreign banks thereby raising the competition in the

market, implies that banks must rely on strengthening their lending and investment operations to remain competitive. In light of these factors, we choose the output orientation for our analysis.

6. Results & Analysis

As can be seen from Table 4, there are potential efficiency gains in all the analysed merger cases with the exception of Merger 2 where the gain is extremely small. The scores indicate the potential gains range from a factor of 1.009 to 2.591 under the production approach and from 1.003 to 1.444 under the intermediation approach. Interestingly, Merger 4 which was the first of the two mergers that were voluntarily initiated by market participants showed the highest potential gain under both the production and intermediation approaches. The results also reveal that, the banks would not be able to take advantage of any technical inefficiencies. However, Mergers 4 and 5 are found to be exceptions to this under the production approach as both show the presence of technical inefficiencies to be an important source of their overall merger gains. These findings thus indicate that the mergers involving the distressed banks provided no scope for gains from technical inefficiency whereas the two market driven mergers between healthy banks offered more technical efficiency gains. According to these results, the driver of the financial weakness of the distressed merger targets was not the under-production of the output, i.e., technical inefficiency. The operational background of these mergers, details of which are provided in the latter part of this section may provide a further clue to explain this. We, further, fail to find scale related potential gains among the mergers studied. The results of an investigation into the returns to scale profile of the merging banks carried out one year prior to the merger using BCC-DEA revealed that most of the banks operated under decreasing returns to scale thereby making the existence of any scale related gains unlikely.

The bulk of the potential efficiency gains from the bank mergers analysed appear to stem primarily from the amalgamation and streamlining of product mixes rather than the eradication of any technical inefficiency. Potential gains under both the production and intermediation approaches can, consequently, be sourced to the harmony effect whereby the re-organisation of the service portfolio of the merged bank provided scope for increased post merger efficiency. This alteration of the product mix may also have the added benefit of lowering the merged bank's credit risk. These harmony gains may thus be the driving force behind the gradual shift towards the establishment of

universal banks. For example, this formed one of the merger motivations for the banks involved in Merger 5. The provision of multiple but related services under one roof would aid in enhancing the efficiency of the banks, as it would allow for the removal of redundant and repetitious production activities.

A caveat, however, is in order at this stage, to the effect that these findings may be specific to the variables chosen. In other words, the banks would not be able to capitalise on any technical inefficiencies from their mergers if there are no technical inefficiencies attached to the use of the chosen variables. This potentially provides another explanation for the preponderance of harmony gains in the overall efficiency gains. The variables do not reflect the costs and expenditures and profitability of the banks. A further analysis that accounts for the profitability of the banks and the levels of their Non Performing Assets (NPAs) would provide more information on the potential for merger gains.

In addition, post merger, under both input-output models, the merged entities show high levels of technical efficiencies indicating potentially, that the dominant partner was able to effectively transplant its more successful operations profile onto its weaker partner.

Overall, average post merger efficiency appeared to be higher under the intermediation approach. This was further investigated using the Kolmogorov-Smirnov test, as specified in Banker and Natarajan, (2004). The results, presented in Table 5, reveal that the average post merger efficiency scores were higher in the intermediation approach than the production approach. The average post merger efficiency is thus sensitive to the input-output specification adopted. The result also signifies a shift away from the quantitative goal attainment nature of banking which characterised the pre-reform regime towards one where banks were afforded greater autonomy in determining their operations and gave emphasis to the intermediation aspect of their operations. In addition, results of the KS test on the presence of scale inefficiency among the banks in the post merger period indicate that the null hypothesis can be rejected thus confirming the presence of scale inefficiency, and justifies the use of the BCC-DEA model in the post merger period.

Using the Mann-Whitney test, we compared the technical efficiency of the merged banks with the control group. Results are presented in Table 6. We find that under the production approach, the mergers led to significantly higher TE Levels for the merged banks in three of the five mergers analysed. These three mergers involved a financially distressed bank and a sound one and were initiated by the Central Bank in a bid to protect the depositors. The results suggest that rather

than contaminating the efficiency of the stronger bank, these mergers raised its efficiency above that of the average technical efficiency of the non-merging banks. It would thus appear that the healthier bank's corporate policies were successfully transplanted into the newly merged entity thereby allowing it to efficiently operate in the market. A review of the post merger efficiency evolution from a base year would help corroborate this theory.

As can further be seen from Table 6, the mergers did not affect the TE Change of the banks in the case of the distressed mergers under the production approach. Since the TE change provides a glimpse into the evolution of the banks' efficiency over time and the TE Level is akin to the ultimate result of this efficiency evolution, our results point to a very interesting conclusion, viz., that these three banks were able to capture an initial efficiency gain courtesy of their mergers and this gain persisted across the post merger years examined as shown by the TE Levels. At the same time, the banks were thus unable to further augment this initial gain over the post merger years. The two market driven mergers, on the other hand, showed a greater efficiency change from their base years than their non-merging counterparts. It can be inferred that, while Mergers 4 and 5 did not raise the efficiency levels of the merged banks vis-à-vis the non-merging banks, they nevertheless experienced a progressive change in their efficiencies per annum - an improvement in the case of the former and deterioration in case of the latter. Thus while, their efficiencies were significantly different from the base year, on a per annum basis, their efficiency status vis-à-vis the non-merging banks remained unchanged. Their mergers failed to provide them with a competitive advantage over their non-merging peers.

Bogetoft and Wang (2005) point out that the dominance of harmony gains is suggestive of potential benefits to be gained from joint ventures and strategic alliances rather than full-scale mergers. Herein lies a potential cause for the above finding. The DRS profile of the merging partners in the case of Merger 5 and the CRS and DRS profile of the partners in Merger 4 further substantiate this argument. In the case of the banking industry though, the scope for joint ventures may be restricted due to the competitive advantage that soft information, obtained through pro-longed close interaction with clients, confers on the bank. Moreover, confidentiality considerations may further limit the degree to which a joint venture would be successful in the case of banks. In such cases, a full-scale merger may provide the only alternative. However, the joint venture may be successful if the banks come together for the development of new technology in which case, post development, the application of the technology is not linked to confidentiality considerations and

competitive advantage erosion. It is noted that the validity of this argument is restricted to market driven mergers.

Additionally, the nature of the mergers themselves also sheds some light on the finding of TE Change of Mergers 4 and 5. Merger 4 involved two new private sector banks. They thus operated with the same technological and corporate culture thereby offering potentially more synergy and scope for efficiency gains. In the latter case, however, the merger was between one new private sector bank and one old private sector bank, i.e., two banks with very different operating profiles. The need to synchronise these divergent operating cultures may have eroded the initial potential efficiency gains from the merger. Moreover, while the merger would give the new private sector bank access to an extensive branch network, new market region and client base, it would, nevertheless, inherit an asset portfolio riddled with NPAs- the treatment of which would potentially have impaired its ability to attain and maintain a high level of post merger technical efficiency.

The merger metric developed in Section 5 further substantiates these findings. Results are presented in Table 7 and Graphs 1 and 2. Under the production approach, for Merger 1, we find that the merger was successful as it captured the potential as indicated by the Bogetoft and Wang model. In addition, it also showed a higher level of efficiency than the control group in the post merger periods. Examining the chronological progression of the differentials, it can be seen that the efficiency gains resulting from the merger persisted across the post merger period. This indicates that the bank was able to sustain the initial efficiency gain the merger endowed it. Similar results are obtained for Mergers 2 and 3. However, with these mergers, the persistence loses strength in the last post merger period.

Under the intermediation approach, all the mergers analysed had significantly higher efficiency levels than the control group. In the case of the mergers involving distressed banks, we find that all the mergers led to technical efficiency scores that were significantly higher than those of the control group. This corroborates the finding of the production approach and further substantiates the view that the stronger merger partner was able to transplant its better management and efficiency practice onto the weaker bank. Unlike the production approach, however, Mergers 4 and 5 had significantly higher efficiency changes than the control group. However, the analysis of the efficiency change under the intermediation approach reveals that only Merger 1 showed an improvement in its technical efficiency subsequent to its merger. Thus while the mergers led to

increased efficiency initially that persisted in the post merger period, the majority of the merged banks failed to capitalise on this head start and further augment their efficiency. Applying our merger metric, Merger 1 shows a movement from Quadrant III, which signals failure of the merger to raise the efficiency of the merged bank to Quadrants II and I. We can thus infer that for this particular merger, the gains took time to materialise. However, having done so, they persist across the period analysed. Merger II shows the reverse pattern. While its initial location is in Quadrants I and II, it moves into Quadrant IV in the last post merger period. It can be inferred from this movement that the momentum of efficiency gains derived from the merger was lost in the last post merger year. Merger 4 shows a gradual movement from Quadrant II to I thereby signalling that for this bank the Bogetoft and Wang potential gain took time to manifest itself. However, despite this initial delay in attaining its merger potential, the bank showed a positive differential vis-à-vis its non-merging counterparts. Merger 3 is revealed to be the most successful among the mergers studied as can be seen from its high level of BW and CG Differentials. There is however, a gradual decline in the level of these gains as can be seen from the gradual movement back towards the origin in the latter part of the post merger years. The movement from Quadrant II to Quadrant I for Merger 4 indicates that for this merger, the gains took time to materialise. However, having manifested themselves they are shown to be persistent across time. Merger 5 is shown to be a partial success as indicated by its position in the second quadrant.

Overall, the results indicate that the mergers possessed considerable gains, the bulk of which stemmed from harmony gains. The banks were able to maintain a high level of post merger technical efficiency. This indicates that the healthier bank was able to transplant its management skills onto the weaker bank. The average efficiencies of the control group, meanwhile, indicate that there remains an appreciable amount of inefficiency among Indian banks.

Whereas, central bank driven mergers dominated this study, the recent rise in voluntary private bank mergers could signal the beginnings of a ripple effect with more banks jumping onto the merger bandwagon in an attempt to emulate the success of the mergers to date and to take advantage the relaxed regulatory climate regarding mergers. Extrapolating from our current findings, these mergers could potentially raise the efficiency of the banks thus enabling them to bolster their profitability and increase their lending services thus ensuring that vital credit percolates down to the various sectors of the economy thereby stimulating economic growth (Sylla, 2006; Levine 1997). This warrants further investigation through the inclusion of profitability measures in

the analysis and provides a direction for future research. Also, for this to occur, the banks must evolve from a passive stance of moulding their operations to ensure compliance with regulation imposed targets to one of active pursuit of a high calibre asset portfolio. The dominance of the intermediation approach suggests that Indian banks have already begun contending with this shift in the nature of their operations.

7. Conclusion

This study has examined the efficiency benefits flowing from post reforms mergers among Indian Banks over the period 1991-92 to 2004-05. Using the Bogetoft and Wang (2005), model, the potential for merger gains is calculated and decomposed into technical, harmony and size efficiency components. We extend this application to evaluate post sample realisations of the potential gains. Post-merger technical efficiency, derived using BCC-DEA, is used to gauge the degree to which the technical efficiency gains have been captured following the completion of the merger for up to a decade. We also provide a metric for judging the success or failure of a merger.

Overall, the results indicate that post reforms, the mergers led to considerable enhancement of efficiencies for the merging banks. The mergers themselves exhibited considerable potential efficiency gains. The greater part of these gains stemmed from the synchronisation of varied but related product mixes. In other words, harmony gains were found to be the main source of the potential efficiency gains. Technical inefficiency was found to be a source of the potential gains in the market mergers analysed under the production approach. Mergers between distressed and strong banks were found to exhibit persistence in efficiency across time. However, they were not found to increase their efficiency from the base year suggesting that the initial boost in efficiency was not built upon. The input-output specification adopted was found to have a significant impact on the efficiency scores obtained. This rising significance of the intermediation approach symbolises the shift in the operational profiles of banks away from solely functioning as regulatory conduits for credit disbursement to the priority sectors towards a more autonomous, profit-oriented operational profile. In other words, while banks are still required to meet priority sector lending targets, (a) these are on a much-reduced scale and (b) the regulatory emphasis is on their roles as profit oriented financial intermediaries. Further, an examination of the nature of the mergers reveals that although the regulations were relaxed and amended to encourage mergers, the impetus for the mergers

remained Central Bank driven. It would thus appear that the economic policy reforms have succeeded in cleaning up the banking system in terms of ridding it of weaker and inefficient banks. However, these banks have simply been merged into healthier banks. Incumbent strong banks did not appear to adopt the merger and acquisition route to raise their efficiencies.

It is noted that the variables used in this study do not reflect the profitability of the banks' activities. Moreover, as noted in Mester (1996), in her study of US banks, efficiency estimates are sensitive to the inclusion or exclusion of risk factors. Altunbas et al (2000), in their study on Japanese banks, find that scale efficiency estimates are affected by the inclusion or exclusion of risk factors. Thus, an analysis that encompasses this aspect of the banks' operations and incorporates the levels of their NPAs would provide more information on the impact of the merger on the bank's efficiency. Furthermore, in light of the dominance of the harmony gains in the overall efficiency gains, the inclusion of variables that proxy the credit risk of the bank would reveal if post-merger, the change in the product mix did indeed allow the merged bank to raise the quality of its asset portfolio and thus, lower its credit risk exposure. Finally, the incorporation of other DEA models in the within-merger analysis would allow for the capture of more details of the potential for efficiency gains from these mergers. This sets the stage for future research.

BIBLIOGRAPHY

Altunbas, Y., Liu, M.H., Molyneux, P., Seth, R., (2000), Efficiency and Risk in Japanese Banking, *Journal of Banking & Finance*, Volume 24, (10), pp. 1605-1628.

Agarwal, R.N., (1996), *Financial Liberalisation in India: A Study of Banking System and Stock Markets*, B.R.Publishing Corporation.

Amel, Dean., Barnes, Colleen., Panetta, Fabio., Salleo, Camelo., (2004), Consolidation and Efficiency in the Financial Sector: A Review of the International Evidence, *Journal of Banking & Finance*, Volume 28, pp. 2493-2519.

Arun, T.G., Turner, J.D., (2002), Financial Sector Reforms in Developing Countries: The Indian Experience, *The World Economy*, (3), (March 25), pp. 429-445.

Banker, Rajiv D., Charnes, A., Cooper, W.W., (1984), Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis, *Management Science*, Volume 30, pp. 1078-1092.

Banker, Rajiv D., Natarajan, Ram., Statistical Tests Based on DEA Efficiency Scores, in W.W. Cooper, L. Seiford and J. Zhu (eds) *Handbook of Data Envelopment Analysis*, Boston, Kluwer Academic Publishers, 2004.

Beena, P.L., (2000), An Analysis of Mergers in the Private Corporate Sector in India, *Working Paper 301*, (August-September), National Institute of Science and Communication (NISCOM), New Delhi, India.

Beena, P.L., 2004, Towards Understanding the Merger-Wave in the Indian Corporate Sector: A Comparative Perspective, *Working Paper 355*, (January), Centre for Development Studies (CDS), Trivandrum, India.

Berger, Allen. N., Humphrey, David B., (1997), Efficiency of Financial Institutions: International Survey and Directions for Future Research, *European Journal of Operational Research*, Volume 40, pp. 141-162.

Bhattacharya, Arunava, Lovell, C.A.K., Sahay, Pankaj, (1997), The Impact of Liberalization on the Productive Efficiency of Indian Commercial Banks, *European Journal of Operational Research*, Volume 98, pp. 332-345.

Bhoi, B.K., (2000), Mergers and Acquisitions: An Indian Experience, *Reserve Bank of India Occasional Papers*, Volume 21, (1) (Summer).

Bogetoft, Peter., Wang, Dexiang., (2005), Estimating the Potential Gains from Mergers, *Journal of Productivity Analysis*, Volume 23, (2), pp. 145-171.

Cassen, Robert., Joshi, Vijay., (1995), *India, The Future of Economic Reform*, Oxford University Press.

Das, Abhiman., Ghosh, Saibal., (2006), Financial Deregulation and Efficiency: An Empirical Analysis of Indian Banks During the Post reform Period, *Review of Financial Economics*, Volume 15, pp. 193-221.

Das, Abhiman, Nag, Ashok, Ray, Subhash., (2004), Liberalization, Ownership, and Efficiency in Indian Banking: A Non-Parametric Approach, *Working Paper Series*, University of Connecticut, Department of Economics.

Deshpande, D.V., (2005), Mergers Consolidating the Banking Industry: A Legal Perspective, Special Issue, *Indian Banks Association Bulletin*, Indian Banks Association, (January), pp. 33-42.

Garden, Kaylee A., Ralston, Deborah E., (1999), The X-Efficiency and Allocative Efficiency Effects of Credit Union Mergers, *Journal of International Financial Markets, Institutions and Money*, Volume 9, pp. 285-301.

Hollander, Myles., Wolfe, Douglas A., *Nonparametric Statistical Methods*, Second Edition, John Wiley & Sons, INC, 1999.

Koetter, Michael., (2005), Evaluating the German Bank Merger Wave, *Discussion Paper Series, Number 05-16,* (March), Tjalling C. Koopmans Research Institute, Utrecht School of economics.

Krishnasamy, Geeta., Ridzwa, Alfieya Hanuum., Perumal, Vignesan., (2003), Malaysian Post Merger Banks' Productivity: Application of Malmquist Productivity Index, *Managerial Finance*, Volume 30, (4), pp. 63-72.

Kumar, Nagesh., (2000), Mergers and Acquisitions by MNEs: Patterns and Implications, *Economic and Political Weekly*, (August 5), pp. 2851-2858.

Lakshminarayanan, P., (2005), Consolidation in the Banking Industry through Mergers and Acquisitions, Special Issue, *Indian Banks Association Bulletin*, Indian Banks Association, (January), pp. 92-99.

Levine, Ross., (1997), Financial Development and Economic Growth: Views and Agenda, *Journal of Economic Literature*, Volume 35, (2) (June), pp. 688-726.

Llewellyn, David T., The New Economics of Banking, No. 5 in SUERF Studies, *SUERF - The European Money and Finance Forum*, ISBN: 90-5143-028-0, http://www.suerf.org/download/studies/study5.pdf.

Mester, Loretta, J., (1996), A Study of Bank Efficiency Taking into Account Risk-Preferences, *Journal of Banking and Finance*, Volume 20, pp. 1023-1045.

Das, A.K., Misra, A.K., January, (2005), Bank Scale Economies, Size and Efficiency: The Indian Experience, Special Issue, *Indian Banks Association Bulletin*, Indian Banks Association, pp. 145-149.

Mohan, Rakesh, (2004), Financial Sector Reforms in India: Policies and Performance Analysis, *RBI Bulletin*, (October).

Peristiani, Stavros., (1997), Do Mergers Improve the X-Efficiency and Scale Efficiency of US Banks? Evidence from the 1980s, *Journal of Money, Credit and Banking*, Volume 29, (3) (August), pp. 326-338.

Ram Mohan, T.T., Ray, Subhash C., (2004), Comparing Performance of Public and Private Sector Banks, A Revenue Maximization Efficiency Approach, *Economic and Political Weekly*, (March 20), pp. 1271-1275.

Ram Mohan, T.T., Ray, Subhash C., Productivity and Efficiency at Public and Private Sector Banks in India, *Indian Institute of Management, Ahmedabad, Working Paper*.

Reddy, Maheshwar., Sree, Vijaya R., (2005), Size: An Arbiter of Performance, Special Issue, *Indian Banks Association Bulletin*, Indian Banks Association, (January).

Report: Revision of Index Numbers of Wholesale prices in India, *Office of the Economic Advisor to the Government of India*, Ministry of Commerce and Industry, (1999), http://eaindustry.nic.in/.

Reserve bank of India, Banking Statistics, various years, http://www.rbi.org.in.

Reserve Bank of India, Banking Statistics 1972-2002, http://www.rbi.org.in.

Reserve Bank of India, Basic Statistical returns of Scheduled Commercial Banks in India, http://www.rbi.org.in.

Reserve Bank of India, Trends and Progress of Banking in India, various years, http://www.rbi.org.in.

Reserve bank of India, Statistical Tables Relating to Banks in India, various years, http://www.rbi.org.in.

Resti, Andrea., (1998), Regulations Can Foster Mergers, Can Mergers Foster Efficiency? The Italian Case, *Journal of Economics and Business*, Volume 50, pp. 157-169.

Saha, Asish., Ravisankar, T.S., (2000), Rating of Indian Commercial Banks: A DEA Approach, *European Journal of Operational Research*, Volume 124, pp. 187-203.

Sealey, C.W., Lindley, J.T., (1977), Inputs, Outputs and the Theory of Production and Costs at Depository Financial Institutions, *Journal of Finance*, Volume 32, pp. 261-281.

Shanmugam, K.R., Das, A., (2004), Efficiency of Indian Commercial Banks During the Reform Period, *Applied Financial Economics*, Volume 14, pp. 681-686.

Sherman, David H., Rupert, Timothy J., (2004), Do Bank Mergers Have Hidden or Foregone Values? Realized and Unrealized Operating Synergies in One Bank Merger, *European Journal of Operational Research*, Forthcoming.

Shirai, Sayuri, (2002), Assessment of India's Banking Sector Reforms From the Perspective of the Governance of The Banking System, *Rejuvenating Bank Finance for Development in Asia and the Pacific*, United Nations.

Siegel, Sidney., *Nonparametric Statistics for the Behavioural Sciences*, McGraw Hill Series in Psychology, McGraw Hill Book Company.

Srimany, Achintya Kumar., Bhattacharya, Kaushik., Measures for Financial Services: A Review with Special Reference to Banking in India, *Reserve Bank of India Occasional Papers*, Reserve Bank of India, Volume 19, pp. 1-38.

Sylla, Richard., (2006), Schumpeter Redux: A Review of Raghuram G. Rajan and Luigi Zingales's Saving Capitalism from the Capitalists, *Journal of Economic Literature*, Volume 44, (2) (June), pp. 391-404.

Vander Vennet, Rudi., (1996), The Effects of Mergers and Acquisitions on the Efficiency and Profitability of EC Credit Institutions, *Journal of Banking & Finance*, Volume 20, pp. 1531-1558.

Van Rooij. M.C.J., (1997), Bank Mergers, Banking efficiency, and Economies of Scale and Scope: A Review of Empirical Literature, *Working Paper*, (August).

Table 2: Post-Reforms Bank Mergers ***(Reproduced from: Lakshminarayanan, Consolidation in the Banking Industry through Mergers and Acquisitions, Indian Banks Association, Special Bulletin, January 2005)***

Sr.	Name of Bank Merged	With whom Merged	[‡]Date of Merger
1	Bank of Karad Ltd.	Bank of India	1993-1994
2	Kashinath Seth Bank	State Bank of India	1995-1996
3	Punjab Co-op. Bank Ltd.	Oriental Bank of Commerce	1996-1997
4	Bari Doab Bank Ltd.	Oriental Bank of Commerce	1996-1997
5	Bareilly Corp. Bank Ltd.	Bank of Baroda	03/06/1999
6	Sikkim Bank Ltd.	Union Bank of India	22/12/1999
7	Times Bank Ltd.	HDFC Bank Ltd.	26/02/2000
8	Benaras State Bank Ltd.	Bank of Baroda	20/07/2002
9	Nedungadi Bank Ltd.	Punjab National Bank	01/02/2003
10	Bank of Madura	ICICI Bank	Mar. 2001
11	Global Trust Bank Ltd.	Oriental Bank of Commerce	24/07/2004

[‡] For mergers where the exact merger date was unavailable, the year of the merger is provided.

Table 3: Input-Output Specifications & Components

MODEL	INPUTS	OUTPUTS
Model 1 (Production Approach)	**Borrowings, Fixed Assets, Other Assets**	**Deposits, Advances, Investments**
Model 2 (Intermediation Approach)	**Borrowings, Fixed Assets, Other Assets, Deposits**	**Advances, Investments**

Input-Output Components Definitions (Source: RBI- Annual Accounts of SCBs):

Borrowings: *Borrowings in India- from RBI; from other banks; from other institutions and agencies, Borrowings outside India*

Fixed Assets*: Premises; assets under constructions; Other fixed assets*

Other Assets: *Net Inter Office Adjustments; interest accrued; tax paid in advance/ tax deducted at source; stamps and stationery; Others (if any)*

Deposits: *Demand Deposits: from banks; from others, Savings Deposits, Term Deposits- from banks; from others, Location wise Deposits- branches in India; branches outside India*

Advances: *Typewise Advances Total- Bills purchased and discounted; cash credit, overdrafts and loans repayable on demand; term loans*

Security wise advances total- advances secured by tangible assets; advances covered by bank and government guarantees; unsecured advances

Sector wise advances total- Advances in India: to the priority sectors; to public sector; to banks; to others

Advances outside India

Investments: *Investments in India- in government securities; in other approved securities; in shares; in debentures and bonds; in subsidiaries and/or joint ventures; in others*

Investments outside India- in government securities; in subsidiaries and/or joint ventures; in others

Table 4: Efficiency Scores & Decomposition for Mergers and Post Merger TE under Models 1 & 2 under CRS & VRS, respectively

MODEL 1 PRODUCTION APPROACH

MERGER	CRS				POST MERGER EFFICIENCY SCORES UNDER BCC-DEA											AVERAGE POST MERGER EFFICIENCY
	OE	TE	HE	SE	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	
1	1.252	1.001	1.251	1.000	0.97	0.97	1.00	0.81	1.00	0.83	1.00	1.00	1.00	1.00	0.95	0.78
2	1.009	1.000	1.009	1.000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.71				0.96
3	1.242	1.000	1.242	1.000	1.00	1.00	0.84	1.00	0.73							0.91
4	2.591	1.549	1.672	1.000	0.58	0.75	0.61	0.99	0.79							0.74
5	1.492	1.258	1.186	1.000	0.91	0.70	0.73	0.78								0.78
6	1.618	1.000	1.618	1.000	1.00	0.73										0.87
7	1.239	1.000	1.239	1.000	1.00	1.00										1.00

MODEL 2 INTERMEDIATION APPROACH

MERGER	CRS				POST MERGER EFFICIENCY SCORES UNDER BCC-DEA											AVERAGE POST MERGER EFFICIENCY
	OE	TE	HE	SE	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	
1	1.069	1.000	1.069	1.000	0.81	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98
2	1.003	1.000	1.003	1.000	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.86				0.86
3	1.286	1.000	1.286	1.000	1.00	1.00	0.98	1.00	0.94							0.98
4	1.444	1.000	1.444	1.000	0.96	1.00	0.98	1.00	1.00							0.99
5	1.208	1.073	1.126	1.000	1.00	1.00	1.00	1.00								1.00
6	1.207	1.000	1.207	1.000	1.00	0.94										0.97
7	1.107	1.002	1.105	1.000	1.00	1.00										1.00

Note: E(t) refers to number of years following the merger. E.g., E1 = 1 year after the merger

Table 5: Kolmogorov-Smirnov Tests on Impact of (a) RTS Specification & (b) Input-Output Model on Technical Efficiency

Kolmogorov-Smirnov Tests on Impact of (a) RTS Specification & (b) Input-Output Model on Technical Efficiency				
	(a) Impact of RTS Assumption on Efficiency		(b) Impact of Input-Output Model on Efficiency	
Test Specification	Model 1 (Production Approach)	Model 2 (Intermediation Approach)	VRS	CRS
D-Statistic (p value)	0.9091 (0.000)*	0.8182 (0.001)*	0.7143 (0.031)*	0.8751 (0.006)*

Table 6: Mann-Whitney Test of TE Change and TE Level Between Merged Banks and Control Group

INPUT-OUTPUT SPECIFICATION		MODEL 1 (PRODUCTION APPROACH)		MODEL 2 (INTERMEDIATION APPROACH)	
MERGERS	§FOCUS	Z STATISTIC (Prob-Value)	†P{ MGTE > CGTE}	Z STATISTIC (Prob-Value)	†P{ MGTE > CGTE}
MERGER 1 (prob-value)	TE LEVEL	4.0210* (0.0001)	1.0000	3.3790* (0.0007)	0.9090
	TE CHANGE	0.4300 (0.6669)	0.5550	3.9770* (0.0001)	1.0000
MERGER 2 (prob-value)	TE LEVEL	2.6350* (0.0084)	0.8750	3.4290* (0.0006)	0.9840
	TE CHANGE	-1.2980 (0.1943)	0.3060	-0.5220 (0.6017)	0.4290
MERGER 3 (prob-value)	TE LEVEL	1.8030** (0.0714)	0.8400	2.6520* (0.0080)	1.0000
	TE CHANGE	0.0000 (1.0000)	0.5000	-1.1690 (0.2425)	0.2500
MERGER 4 (prob-value)	TE LEVEL	0.3140 (0.7533)	0.4400	2.6520* (0.0080)	1.0000
	TE CHANGE	2.3230* (0.0202)	1.0000	0.8930 (0.3719)	0.6880
MERGER 5 (prob-value)	TE LEVEL	0.2900 (0.7715)	0.5630	2.4770* (0.0132)	1.0000
	TE CHANGE	-1.9930* (0.0463)	0.000*	-1.5490 (0.1213)	0.1670

* Significant at the 5% level

** Significant at the 10% level

§ TE Level is the comparison between the TE of the merged bank in a particular year with the Average TE of the control group in the same year. TE change refers to the comparison of the change in efficiency of the merged group from a base year with the change in efficiency of the control group from the same base year over the same time period. The first post merger year is taken to be the base year.

† MGTE refers to the TE of the Merged Bank and CGTE refers to the TE of the Control Group.

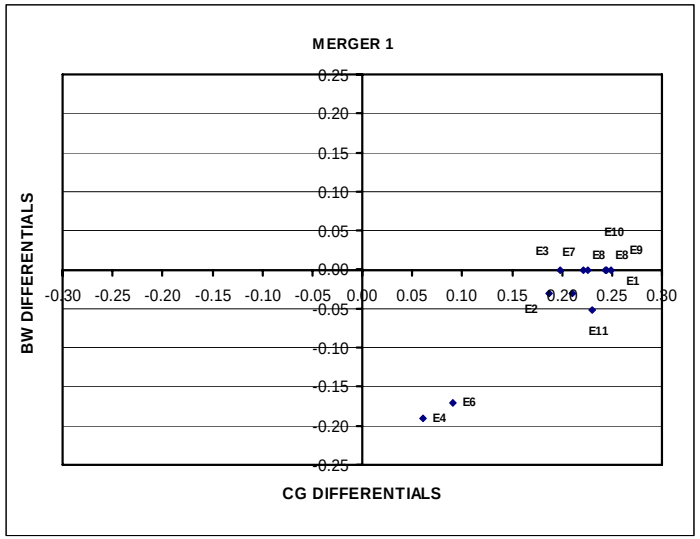
Table 7: BW & CG Differentials under Model 1 (Production Approach) & Model 2 (Intermediation Approach)

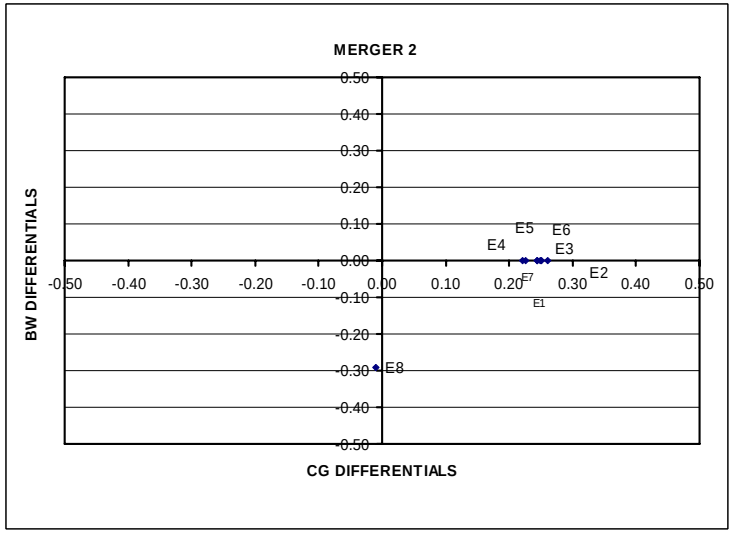
POST MERGER YEARS (MODEL 1: PRODUCTION APPROACH)												
MERGER	DIFFERENTIALS*	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
MERGER 1	BW	-0.031	-0.031	-0.001	-0.191	-0.001	-0.171	-0.001	-0.001	-0.001	-0.001	-0.051
	CG	0.210	0.187	0.198	0.061	0.249	0.091	0.221	0.225	0.245	0.244	0.230
MERGER 2	BW	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.290			
	CG	0.251	0.249	0.261	0.221	0.225	0.245	0.244	-0.010			
MERGER 3	BW	0.000	0.000	-0.160	0.000	-0.270						
	CG	0.221	0.225	0.085	0.244	0.010						

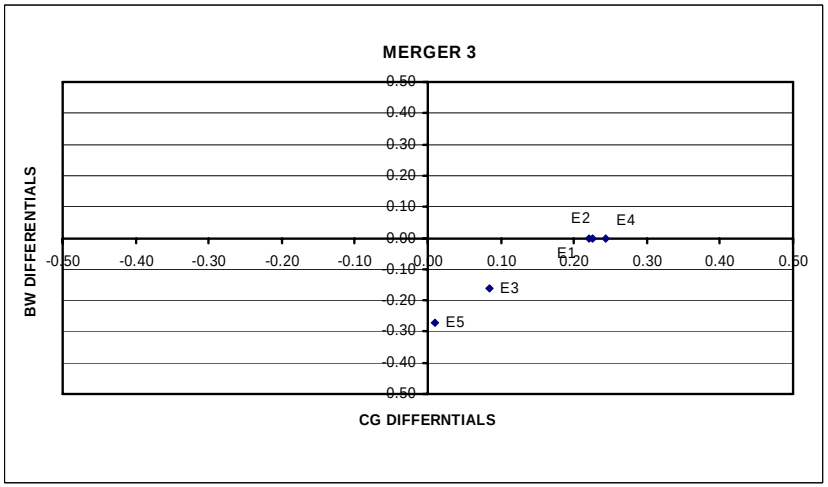
POST MERGER YEARS (MODEL 2: INTERMEDIATION APPROACH)												
MERGER	DIFFERENTIALS	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11
MERGER 1	BW	-0.190	-0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	CG	-0.144	0.141	0.114	0.172	0.168	0.175	0.174	0.183	0.183	0.149	0.121
MERGER 2	BW	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-0.140			
	CG	0.172	0.168	0.175	0.174	0.183	0.183	0.149	-0.019			
MERGER 3	BW	0.174	0.174	0.154	0.174	0.114						
	CG	0.174	0.183	0.163	0.149	0.061						
MERGER 4	BW	-0.040	0.000	-0.020	0.000	0.000						
	CG	0.134	0.183	0.163	0.149	0.121						
MERGER 5	BW	-0.073	-0.073	-0.073	-0.073							
	CG	0.183	0.183	0.149	0.121							

* BW differential refers to the Bogetoft & Wang Differential which is calculated as the merged bank's post merger TE less the Bogetoft & Wang Potential TE. CG Differential refers to the Control Group Differential which is calculated as the difference between the post merger TE in period E1 of the merged bank less the TE of the control group for the same period.

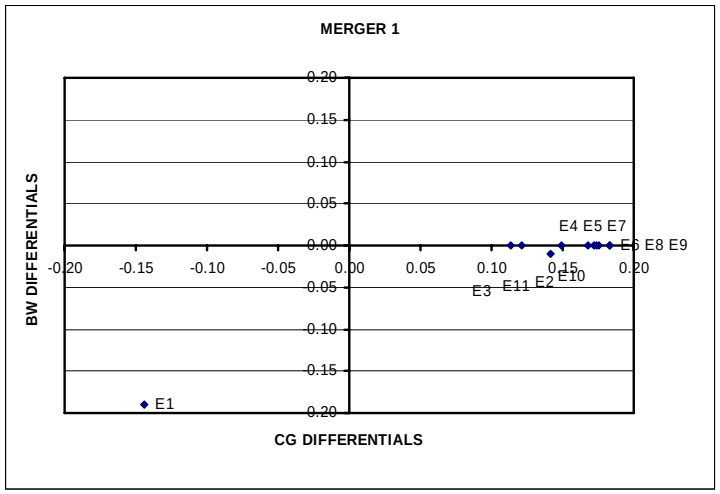
Graph 1: Merger Metric – Model 1 (Production Approach)

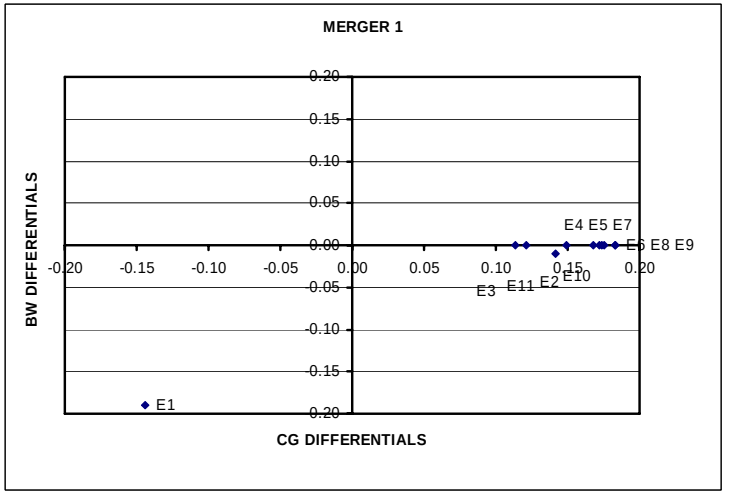


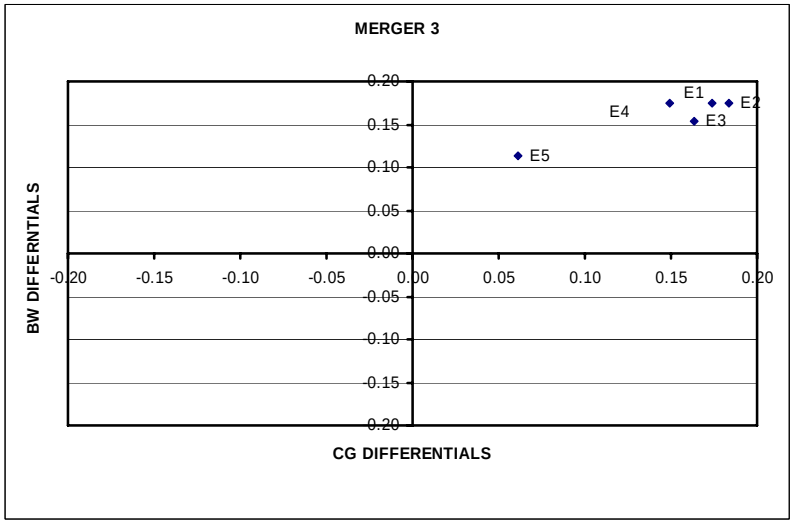




Graph 2: Merger Metric – Model 2 (Intermediation Approach)







Graph 2: Merger Metric – Model 2 (Intermediation Approach), Cont'd