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Analysing the Promised Effect of Liberalization on Banking Sector Efficiency in Ghana

By Frank Prah

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I. Introduction

The neo-classical hypothesis that prices in a free competitive market system holds the potency to ensuring efficiency in production and supply of goods and services, as well as efficiency in consumption through price stability and product availability, is the bedrock upon which financial sector liberalization policies were formulated. These policies were proposed and aggressively implemented in the 1980s in many developing economies that were identified to have been bedeviled with "financial repression" (McKinnon, 1972; Shaw, 1972). Since then, financial liberalization has become the major principle for financial sector policies.

The main aim of financial sector liberalization is to remove market rigidities in the form of monopolies and external controls in order to promote competition among firms. Improvements in competition are expected in turn to lead to efficient pricing and allocation of financial resources needed for economic growth and development. (Barajas et al., 1999; Leon, 2012) Increasing levels of competition and efficiency in the financial markets are thus expected, almost automatically, to be the outcome of deepening financial sector liberalization. Though it may be volatile, interest rates are expected to be downward trending while expanded product availability is assured to follow the policy (Caprio, Honohan and Stiglitz, 2001).

To this end, financial sector liberalization policies were adopted in Ghana in the late 1980s with the aim of creating a "free market" environment which was considered necessary for improving market competition and efficiency. Prah (2014) provides evidence to show that the market structure of the Ghanaian banking industry improved substantially during the last decade. Nevertheless, interest rates and availability of funds should be considered key indicators for gauging benefits from financial sector liberalization to consumers, especially in a previously "re-repressed" financial sector. This is because the ultimate promise of the liberalization theory is the emergence of an efficient market; a condition that should reflect in the prices and availability of goods and services produced in the market. In particular, the spread between lending and interest rates reflects how efficient a banking system is performing its traditional role which is financial intermediation.

Interest rates and related spreads in the Ghanaian money market have received significant level of attention in recent times by the Central Bank of Ghana, the Association of Ghana Industries (AGI) and other financial service consumer groups. Though the level of inflation has seen significant reduction during the past years, from an annual average of 32.9 per cent in 2001 to 8.68 per cent in 2011, the average lending rate charged by commercial banks has remained well above 20 per cent for more than two decades. The general feeling is that the cost of borrowing or the lending rates are just too high especially when compared with the corresponding deposits rates and the general level of prices in the economy. This raises the question of whether market efficiency is improving or worsening amidst the on-going sector liberalization.

In a review of studies on efficiency among financial institutions, Humphrey (1997) observed that liberalization might not always be efficiency and productivity enhancing. Thus it is important to examine from time to time whether liberalization policies being implemented are enhancing efficiency or not so that unintended negative effects are corrected while positive ones are consciously reinforced. In the light of this, it is necessary to ascertain empirically whether the Ghanaian banking sector efficiency has improved over the years that financial liberalization policies have been continuously implemented. This study therefore assesses the evolution of banking sector efficiency in Ghana from 2000 to 2011. The main hypothesis to be tested is that financial liberalization has led to a continuous improvement in banking sector efficiency in Ghana.

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II. Market Performance of Deposit Money Banks in Ghana (1990 – 2012)

According to the Ghana Financial System Stability Assessment Update report (IMF, 2011), deposit money banks (DMB9 or commercial banks) in Ghana control more than 70 per cent of total assets of the entire financial system and more than 88 per cent of total assets of the Banking system. This makes DMBs the back bone of both the banking sector and the entire financial system. Thus, several studies on Ghana, such as Quartey and Prah (2008), have used the commercial banking sector as proxy for the financial system in Ghana.

Table 1: Performances of Deposit Money Banks in Ghana (2000 – 2012)

Year	00	01	02	03	04	05	06	07	08	09	10	11	12
Number of Banks	16	17	17	18	18	20	23	23	25	26	26	27	26
Branches	304	326	322	329	384	378	450	595	640	706	776	795	859
Assets (% of GDP)	44.0	41.1	39.4	37.6	39.1	38.6	27.3	32.9	34.5	38.1	37.5	36.1	37.5
Loans(% of GDP)	10.8	13.3	12.6	10.4	12.9	13.1	9.6	10.9	12.7	16.2	15.0	13.4	13.1
Deposits(% of GDP)	12.3	12.1	14.6	16.1	18.5	19.8	11.9	13.8	14.7	17.2	17.5	17.7	19.5
Composition of Income													
Other Income	17.9	7.7	11.9	9.4	9	8.5	7.8	7.6	12.7	11	7.1	12.3	11.9
Commissions and Fees	15.6	14.7	21.1	19.3	21	20.5	20.7	21.5	17.8	14.8	14.9	18.1	17.7
Loans	32.4	39.3	40.7	36.1	39.3	40.6	44.9	49.4	55.3	58.7	55.9	46.4	47
Investments	34.2	38.3	26.3	35.2	30.7	30.4	26.7	21.5	14.3	15.4	22.1	23.3	23.5
Liquidity and Capital Adequacy													
Liquid Assets to Total Deposits	-	-	-	-	-	-	36	37	38.8	41.1	37.3	38.4	33.6
CAR	11.4	14.7	13.4	9.3	15.3	16.2	15.8	15.7	13.8	18.2	19.1	17.4	18.6
Asset Quality													
NPL Ratio	11.9	19.6	22.7	18.3	16.1	13	7.9	6.9	7.7	16.2	17.6	14.1	13.2
Loan Loss Provision to Gross Loan	7.1	10	13.5	11.4	9.3	8.5	5.77	4.73	5.13	9.42	9.37	7.68	6.43
Earning Indicators													
Gross Yield	23.4	25.7	22.3	19.3	19.2	17.2	16	14.9	17	20.4	19.5	15.3	15.9
Net Interest Margin/Gross Income	40.3	50	47.9	49.3	50.7	51.6	51.8	46.1	41.3	39.4	50.1	46.8	48.5
Profitability Ratio	28.2	21.9	23.1	20.2	22.8	16.5	19	16.2	13.3	9.8	14.6	17.8	21.5
Return on Assets (before tax)	10.4	8.6	7.9	6.5	6.4	4.8	*3.3*	*2.6*	*2.5*	*2.1*	*2.7*	*2.8*	*3.6*
Return on Equity (before tax)	65.2	44.2	48.4	35.2	35.5	25	*39.6*	*35.8*	*30.1*	*23.6*	*28.6*	*27.2*	*34.6*
Operational Efficiency													
Cost to Income	71.8	78.1	78.95	79.8	81.65	83.5	81	83.9	86.9	90.1	85.4	82.4	78.7
Operational Cost to Gross Income	45.5	50.5	54.15	57.8	60.95	64.1	61.2	59.1	58.6	55.4	57.5	59.5	56.7
Cost to Total Assets	16.5	18.7	16.55	14.4	14.3	14.2	12.3	11.7	13.8	15.8	14.3	11.6	12.1
Operational Cost to Total Assets	10.5	12.1	11.3	10.5	10.7	10.9	9.3	8.3	9.3	9.7	9.6	8.4	8.8

Source: Bank of Ghana, Financial Stability Report (various issues) and Ghana Statistical Services

Several changes have occurred in the deposit money banking sector in recent years. As indicated in Table1, the number of licensed banks almost doubled between 1999 and 2012, with almost a threefold increase in the total number of branches operated by the banks. These indicate substantial expansion in coverage and access to banking services in the country. Also, the balance sheets of the sector have expanded substantially over time. Total assets increased from 19.4 per cent in 1990 to 37.3 per cent of GDP in 2012, albeit there were some intermittent fluctuations. Much of the increases were from domestic sources. The share of total outstanding credits to the private sector, public enterprises and the central government increased from 4.4 per cent in 1990 to 24.8 per cent of GDP in 2012. Improvements in credit advancements were accompanied by similar improvements in the mobilization of deposits. Deposits from the private sector increased more than half of total liabilities during the period under review.

However, a linear trend analysis shows that all major income components, except interest incomes on loans, had negative gradients. This means average income from those sources reduced. On the other hand, interest income on loans increased from 32.4 per cent of total income in 2000 to a peak of 58.7 per cent in 2009 before reverting to 47 per cent in 2012. Interest income on loans constituted about 45 per cent of total income from 2000 to 2012. This was followed by investment income (26.3%), commissions and fees (18.3%) and other income (10.4%) respectively.

Liquidity in the market has generally been unstable. Available data indicates that liquid assets to total deposits and total assets all increased from 2005 to 2009 but have since been reducing. Nevertheless, there has been a continuous improvement in equity resulting in the market capital adequacy ratio hovering above 10 per cent in the entire period except the minimum 9.3 per cent recorded in 2003. Even though the banks were generally well capitalized, more efforts were still required to stem credit risk, especially during the latter part of the period. Non-performing loans to asset ratio reduced significantly from above 20 per cent in 2002 to below 10 per cent from 2006 to 2008. From 2009, however, the ratio remained above 13.2 per cent. The NPL was again more than 5 per cent above total gross loans. These have implications to efficiency and profitability in the sector.

A trend analysis of the various profitability indicators unanimously show that profitability generally decreased during the period under study. However, since 2010, there had been a greater tendency for industry profits to rise. For example, even though profitability ratio decreased from 28.2 per cent in 2000 to 9.8 per cent in 2009, the ratio improved afterwards to about 21.5 per cent in 2012. Comparing profitability trends to those of income and credit risk, it appears that during the last three years in the period, banks benefitted in terms of high returns for taking more risk.

Finally, a similar trend analysis of ratio measures for management efficiency was rather inconclusive. Whereas cost to income ratios indicate that, on average, management efficiency reduced over the period, cost to assets ratios indicated otherwise. This also underscores the need for more comprehensive measurement and analysis of efficiency, hence the objectives of this current study.

III. Literature Review

The importance of financial system efficiency is well noted in the literature. Countries with efficient financial system are found to be less prone to financial crises, currency crises, and grow faster (Barajas et al., 1999; Caprio, Honohan and Stiglitz, 2001; and Leon, 2012). An inefficient financial system is believed to lead to the destruction of wealth, as consumers are forced to pay higher than optimal price for inevitable financial services. Such a system also directs funds to less efficient sectors of the economy leading to inefficient utilization of society's scarce financial resources. Therefore, improving the efficiency of the financial sector does not only improve fund utilization for growth, but also ensure effective redistribution of wealth from financial firms to their consumers.

Implementation of financial sector liberalization policies hinges on the assumption that removing market barriers will enhance competition in the market which would in turn lead to efficiency in pricing and production. Common among liberal economists and in many studies, efficiency is assumed to emerge automatically from competition. Thus many past studies on the market impact of liberalization have been based on measures of market competition. However, it is imperative to directly measure efficiency rather than to deduce it theoretically as a direct function of competition.

Literature on bank sector efficiency in Ghana is relatively limited and mainly based on Data Envelopment Analysis (DEA) to measure relative efficiency among banks. In one of the earliest empirical study on Ghana, Korsah et al. (2001) applies DEA within the intermediation frame work on annual data for some selected banks from 1988 to 1999. They established that bank efficiency improved but stagnated at the letter period. To extend this study, Akoena et al (2009) used annual data from 2000 to 2006 on 16 selected commercial banks to investigate the changes in technical efficiency and economies of scale of the banks and to test whether large banks were more efficient than small banks in anticipation of impending recapitalization requirements by the central bank. The study uses DEA and runs five different models within the production and intermediation approaches to DEA in banking sector. They established that the overall technical efficiencies of large and small banks were similar but scale efficiencies of small banks were found to be larger than big banks. From this finding, they cautioned the central bank against encouraging banks to get bigger, especially if the objective of the recapitalization was to improve efficiency among the banks.

Examining the relative efficiency of banks in Ghana during the year 2007 and to investigate the linkage between efficiency and profitability, Frimpong (2010) also used intermediation approach to DEA to estimate relative technical efficiency of 22 banks in Ghana, based on constant returns to scale (CRS) assumption. He found that only 4 banks were efficient. The 18 inefficient banks had inefficiency ranging from 33% to 89% and the sector's average technical efficiency (at CRS) was 74%. Among the 22 banks, domestic private banks were most efficient followed by foreign and state banks respectively. In a most recent study on Ghana, Adjei-Frimpong et al (2014) also used DEA under intermediation approach to analyses cost efficiency of the banking industry. Static and dynamic panel data models were further employed to ascertain the impact of size, capitalization, loan loss provision, inflation rate and GDP growth rate on efficiency. The data involved annual unbalanced panel of 25 banks from 2001-2010. From the empirical results, they concluded that Ghanaian banks are cost inefficient though well capitalized banks are less cost inefficient. They further established that bank size has no effect on cost efficiency, meaning large banks have no advantage over smaller ones. Loan loss provision was also found to not significantly determine cost efficiency of banks. On the other hand, GDP growth rate was found to negatively influence bank cost efficiency while lagged cost efficiency persisted over time.

Besides Ghana, several studies on bank sector efficiency have been conducted on other developing economies (Hauner and Peiris, 2005 for Uganda; Tahir et al, 2009 for Malaysia; Sathy, 2002 and Kumar and

Gulati, 2008 all for India; and Chen et al, 2005 for China). Similar studies on relatively advanced markets also exist in the empirical literature, such as Drake et al (2009) for Japan. Although DEA is the most utilized methodology in the bank efficiency literature, alternative methods have as well been used. For example, Park and Weber (2006) applied Luenberger (1992) distance function to measure technical efficiency changes among South Korean banks. Perhaps, the next most popular methodology to DEA in the literature is the Stochastic Frontier Analysis (SFA). Yet, Kablan (2007) combines DEA and SFA on banks in the West African Economic and Monetary Union, WAEMU. He establishes that the stochastic frontier measure gives similar efficiency evolutions to those by DEA.

This study seeks to contribute to the empirical literature on Ghana by improving on the earlier mentioned studies on Ghana in a number of ways. The most important is the recognition that financial liberalization is a process and thus must be assessed over time. This study believes that assessing changes in bank efficiency over time is a more appropriate means to assess the impact of financial liberalization than at a point time (exemplified by Frimpong, 2010). Though Korsah et al (2001), Akoana et al 2009) and Adjei-Frinpong et al (2014) all sought to analyses changes in efficiency over time, they rather restricted the sample to banks that had been operating for some number of years or banks on which data was available to the researchers. Even though these considerations were ethical, they fail to account for the fact that the DEA efficiency scores are defined only in relation to the set of banks used in the analysis. Therefore, a bank is DEA efficient relative to those included in the set but not to those omitted. Significantly different results could be obtained if the omitted banks were to be included in the sample since that would amount to estimating a different market frontier. Hence, a more comprehensive assessment of a policy impact on banks in operating within a common market, with exposure to common environmental factors such as regulatory regime and other policy intervention, should be based on all the banks in the same market. However, the cited studies failed to achieve this feet and may possibly have miscalculated the banks' relative efficiencies.

Also, Drake et al (2009) studies the Japanese banking system by combining all the three known approaches to modeling input-output variable set for DEA on banks, namely intermediation, profit and production approaches. They found significant differences in mean efficiency scores, dispersion of efficiency scores, and ranking of banks and sectors depending on the choice of model. This high degree of model dependency, they argue, has important implication to policy formulation. Each approach has distinctive policy orientation and thus different implied intervention to be adopted. Although Akoena et al (2009) found some evidence of model dependency they utilized only the intermediation and the production approach. None of the cited studies on Ghana has so far explored the combination of all three approaches.

Finally, some empirical studies embarked on a second stage DEA analysis which involves regression analysis to determine the factors explaining the differences in the observed relative efficiency scores among the units. Even though Adjei-Frinpong et al (2014) is the only sited study on Ghana in this regard, they admit that the data points were less than desired and thus interpreted their results with caution. One possible reason for a general short-fall of such regression analysis on Ghana is because of the small number of estimated data points for efficiency scores. Annual data used in all previous studies provided insufficient sample size which could have led to inconsistencies in the estimated parameters. To this end, this study seeks to contribute immensely to literature and empirical data by generating sufficient efficiency scores for regression analysis. In all, the current study estimates quarterly efficiency scores on all registered banks in Ghana, using all the three alternative approaches to DEA identified in the literature on banking studies and for all the three main returns to scale assumptions common in DEA (constant, variable and increasing return to scale).

IV. Methodology

a) Data

The current study is based on quarterly-bank unbalanced panel of all registered deposit money banks (DMBs) in Ghana from September 2000 to December 201. During the period, the number of banks increased from 17 in 2000 to 271. Also, there were three cases of take-over and one merger but each case is treated in the sample as a single entity in progress. New entrant banks are allowed to enter the data at as-and-when basis. Contrary to what is done in previous studies where banks are selected based on availability of data for the entire period under study, this study involves all banks even though with different data span. These data dynamics are allowed to play out naturally in the data rather than restrict the shape of the data to few banks. The study believes strongly that these dynamics are part of the complex process that affect the strategic decisions of competing banks and hence a product of a dynamic competitive market. Additionally, the changing data structure reflects the very object under study, namely banking sector liberalization. In all, a total of 979 observations on 30 different licensed DMBs were utilized. The data excludes all quasi-banking institutions and were sourced from Bank of Ghana.

New entrant banks are allowed to enter the data at as-and-when basis to reflect the changing influence they brought to the market frontier. This could lead to the emergence of new frontier DMU's at different points in time. The data excludes all quasi-banking institutions that are not licensed to operate as "banks" in accord with the Ghana Banking Act, 2004.

b) Definition and measurement of Efficiency

Firm efficiency is generally conceived in terms of the ability to generate maximum output, or a set of outputs, with a given input, or set of inputs. It can also be defined by the ability to minimize total cost at a given output or sets of output. Farrell (1957) is credited with the pioneering work in the measurement of efficiency among firms in modern times. Modern methods of efficiency measurement employ frontier analysis which involves a systematic separation of 'best' performing institutions from the less performing ones based on defined objectives and standard. Based on a basic assumption that the production function or iso quant of the truly and fully efficient firm is known, a frontier, which establishes the criterion for separating an efficient firm from the non-efficient firm, is constructed. Firms on the frontier are considered efficient where as those below or within are regarded less-efficient. However, the assumption that the true isoquant or production function of the fully efficient firm is known is not borne out of reality. Rather, the theory requires that a production function or isoquant be constructed from an observed sample data.

Farrell proposed two competing groups of methodologies for constructing these relative frontiers. First, the parametric function approach involves an econometric estimation of a production or cost function that seeks to fit the data such that no observed coordinate of a firm in the input-output plane should lie either to the left or below the fitted line. The stochastic frontier approach is most sited example in the empirical literature. The most sited limitations of this group of techniques, however, has to do with the consequences of functional form misspecification and incorrect design of input-output matrix both of which are found to lead to inconsistency in the estimated parameters (Hassan, 2008).

The alternative option, the non-parametric approach, involves the construction of a piecewise-linear convex isoquant such that no observation lies within the frontier. The most utilized non-parametric method in the empirical literature is Date Envelopment Analysis (DEA). Hassan (2008) list several advantages of using DEA. First, by recognizing that firms have different production functions, the DEA does not impose a specific functional form for the frontier, thus overcoming the functional form misspecification problem with the parametric approach. It can be applied to problems involving multiple inputs and outputs, for measuring variable returns to scale as well as evaluating allocative efficiency.

Also, since the optimization process involved is applied to each firm, estimates of individual firm parameters are obtained which are useful for intra-industry analysis. Moreover, it can be used to evaluate the performances of different departments or branches of the same economic entity. Nevertheless, the DEA methodology has certain challenges the knowledge of which should guide how it is formulated and applied in empirical analysis. Before highlighting these limitations, though, it is fitting to present the theory behind this approach. The next section therefore presents the DEA framework and how the identified limitations are mitigated in this study.

c) Data Envelopment Analysis

The Date Envelopment Analysis is a mathematical programming framework used to calculate the relative efficiency of a set of decision making units (DMUs) by comparing the performance of each member of the set to the best practice in the set. The inefficiency of a particular DMU is derived by calculating how far it is from a peer regarded as efficient in the same set because it is on the frontier predefined by a specific standard. The mathematical derivation and explanations to the DEA procedure was originally developed by Charnes, Cooper and Rhodes (1978) but has since been extended into various forms and are well documented in both theoretical and empirical literature (Banker et al., 1984; Seiford and Thral, 1990; Lovell and Schmidt, 1993, and 1994; Ali and Seiford, 1993; Charnes et al., 1995 and Seiford, 1996 and Coelli 1996). Assuming that there are *N* similar units of DMUs that converts a matrix of *KxN* inputs, *X*, into *MxN* output, *Y*, the objective of DEA is to construct a non-parametric envelopment frontier over the observed data on output(s) and given input(s) such that no points lie within or below the frontier. To measure the efficiency of the best practice unit that lie on the frontier, Charnes et al. (1978) propose that the ratio of weighted outputs to weighted inputs for this unit be maximized subject to the constraint that similar ratios for all other DMUs in the set are less than or equal to one. This linear programming problem is defined mathematically by LP(1):

$$Max_{u,v} e^i = \frac{u_i^{'} y_i}{v_i^{'} x_i}$$
$$\text{St.} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots LP(1)$$
$$\frac{u_j^{'} y_j}{v_j^{'} x_j} \leq 1,\ j = 1,2,\ldots,N$$
$$u, v \geq 0,$$

Where yi is a vector of output produced by DMUi using the input vector xi, and the corresponding efficiency measure is defined by ei. The solution to the problem involves choosing the optimal weights, u* and v*, that maximizes ei subject to the constraints. The fully efficient DMU is unknown and every unit in the set can be the ideal DMU. Therefore the optimization process is repeated for all DMUs in the set. The unit that attains an efficiency score of one (ei =1) satisfies the necessary condition to be DEA efficient whereas those with efficiency score of less than one (i.eei ≤ 1) are DEA inefficient.

By this process, the DEA methodology generates web-like linear combinations of outputs and inputs among the efficient DMUs such that virtual producers are created as reference points for calculating the inefficiency of all other DMUs in the same group. In this sense, the estimated efficiencies are "relative" (Hassan, 2008) and are strictly defined within a specific set of DMUs in a specified period of time.

However, the specification in PL(1) has infinite solution and hence infeasible since the problem is non-linear and fractional. Based on the theory of fractional linear programming, Normalizing the problem in LP(1) by setting input ratio for DMUi to 1 (i.e 1 ' ☐ i v x), as suggested in Charnes et al (1978) and taking the dual generate a more simplified problem specified as

$$Min_{\theta,\lambda} \theta,$$
$$\text{St.} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots LP(2)$$
$$-y_i + Y\lambda \geq 0,$$
$$\theta x_i - X\lambda \geq 0,$$
$$\lambda \geq 0$$
$$i = 1,2\ldots\ldots,N,$$

where θis the efficiency score and λ is Nx1 vector of constants. An efficient DMU has a DEA efficiency score as previously defined. The dual problem in LP (2) has lower number of restrictions than in LP(2) and is usually the preferred solution (Coelli, 1996).

d) Key Issues with DEA Specification

The LP (2) is specified for measuring technical efficiency as defined by Farrell (1957), which is the ability of DMUs, operating at constant returns to scale to obtain maximum set of outputs from a given set of inputs. It is also derived as an orientated model developed in Charne set al (1978) and Banker et al (1984) rather than as additive model (Charnes et al. 1985). The Farrell measure of technical efficiency involves the utilization of a piecewise linear frontier which often involve the situation where the frontier runs parallel to either the input or output axis or both. This means that, it is possible to find an efficient DMU that could reduce some inputs while maintaining its output level or vice versa. These excess inputs or shortfalls in outputs are called input slacks or output slacks respectively. Presences of slacks represent violations of the neoclassical production assumptions behind the definition of efficiency and which leads to deficiencies in the technical efficiency measure proposed by Farrell (Drake et al, 2009).

On the other hand, Koopman (1951) provides a stricter definition of a technically efficient DMU as one that operates on the frontier and has no slacks in input or output. Thus, in order to conduct a more accurate DEA efficiency measure, both the Farrell measure of technical efficiency and non-zero input/output slacks must be reported. This study adopts the orientated approach for dealing with slacks in the DEA of Ghanaian banks. The study adopts the multi *stage DEA* slack solution proposed in Coelli (1998) to overcome the limitations of the two-stage approach to orientated modeling for sealing with slacks. The methodology involves a sequence of radial movements to solving oriented DEAs which leads to unit-invariant efficiency scores and the selection of more appropriate peers. The relevance of slacks to this study has been occasioned by the facts that the study seeks to derive the stated advantages of DEA and insists on measuring

Koopman's technical efficiency for Ghanaian banks. If slacks were ignored, it could have led to wrongly assigning an inefficient DMU as efficient (Drake et al, 2009).

The LP (2) is found to be valid only when all DMUs in the relevant set are operating at constant returns to scale or at the optimal scale (Banker et al., 1984). When constant returns to scale is assumed, the Farrel measure of technical efficiency in LP(2) captures the *overall technical efficiency* (OTE), maximizing both the input-output mix (managerial or pure technical efficiency, PTE) as well as the size of operation (scale efficiency, SE) (Kumar and Gulati, 2008). However, when this assumption breaks down and DMUs operate at below optimal, LP (2) accounts for only pure technical efficiency. Since the banking sector in Ghana is not fully developed, the constant return to scale assumption is not plausible for all banks and hence LP (2) cannot be exclusively applied to such a market.

Several production constraints and market imperfections are found to exist in the Ghanaian banking sector (Prah, 2014; Bucks and Mathisen, 2005; Bawumia, Belnye and Ofori, 2005). Performing only the constant returns to scale DEA (CRS) will lead to a difficulty in determining the source of an observed relative inefficiency in a DMU; that is whether inefficiency was due to discrepancies in scale utilization (ie. scale efficiency, SE) or due to deficiencies in managerial ability to adopt the most appropriate input mix for the available scale of operation (ie. pure technical efficiency, PTE).

In order to decompose the overall technical inefficiency into the sources of inefficiencies, Banker et al. (1984) suggest that a convexity restriction be imposed as an additional constraint in LP (3). The resultant model is the variable returns to scale (VRS) version of the LP specified as

$$\begin{aligned} & Min_{\theta,\lambda}\theta, \\ & \text{St.} \qquad \text{..................................LP(4)} \\ & -y_i + Y\lambda \geq 0, \\ & \theta x_i - X\lambda \geq 0, \\ & \lambda \geq 0 \\ & NI'\lambda = 1 \\ & i = 1,2.....,N, \end{aligned}$$

where is an Nx1 vector of ones (1). The efficiency measure and all other variables remain unchanged. The efficiency score from the VRS model are greater than or equal to those derived from the CRS model. The two measures are mutually exclusive and non-additive. A divergence between the two measures means that the respective DMU has scale inefficiency (SE) defined by ' NI

$$SE = \frac{TE_{CRS}}{TE_{VRS}} \qquad \text{......................(10)}$$

Estimates of LP (3), LP (4) and equation (10) generate estimates for the overall technical efficiency (OTE) scores under the CRS assumption, the pure technical efficiency (PTE) scores under the VRS assumption, and the scale efficiency (SE) scores as the difference between CRS and VRS scores. As mentioned earlier, all efficiency measures are bounded by zero and 1. A bank is considered DEA efficient if it attains an efficiency score of 1 or DEA inefficient if the score is less than 1. An efficient bank is considered *overall* (or fully) technical efficient (OTE) if it is both *pure technical* (PTE) and *scale efficient* (SE). Such a bank serves as the bench mark or best practice for other banks in the same market both in terms of management's ability to organize inputs in the right mix (PTE) and for choosing the right scale of production (SE). On the other hand, a bank may be either pure technically (PTE) inefficient or scale (SE) inefficient or both.

Finally, the nature of scale inefficiency can be determined by determining whether the scale inefficient DMU lies either on the increasing returns to scale or on the decreasing returns to scale side of the VRS frontier. This is achieved by imposing a Non-Increasing Returns to Scale (NIRS) assumption to the model as follows:

$$
\begin{aligned}
& Min_{\theta,\lambda}\theta, \\
& \text{St.} \qquad \qquad \qquad \qquad \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{LP(6)} \\
& -y_i + Y\lambda \geq 0, \\
& \theta x_i - X\lambda \geq 0, \\
& \lambda \geq 0 \\
& NI'\lambda \leq 1 \\
& i = 1,2.....,N,
\end{aligned}
$$

where all variables are defined as previously. The LP (6) is similar to LP (4) in all aspects except that the NIRS restriction $(NI'\lambda \leq 1)$ replaces the VRS restriction $(NI'\lambda = 1)$.

The NIRS efficiency score is greater than or equal to the VRS score and is compared to the VRS score to determine the nature of scale inefficiency. If they are equal then the estimated scale inefficiency is a decreasing return to scale; otherwise it is an increasing return to scale. Kumar and Gulati (2008) explain the implication of scale inefficiency to a bank. A scale inefficient bank due to decreasing returns is deemed too large and thus operating at a 'supra-optimum' scale. On the other hand, a scale inefficient bank due to increasing return to scale or economies of scale is considered too small to fully utilize the available scale of operation and hence operating below its optimal level. Finally, a bank operating at constant return to scale is operating at its optimal scale and hence considered scale efficient. Based on the foregoing, the study runs LP(3), LP(4) and LP(6) to determine the relative efficiencies for all registered banks in a period.

e) *Choice of Input and Output Variables*

One important advantage of the DEA methodology is the flexibility with which alternative variables can be selected as inputs or outputs especially with feasible managerial control in mind. Unfortunately, this advantage introduces a lot more sensitivity in the efficiency measure and renders the estimated efficiency scores susceptible to the choice of input-output variables. There is no consensus in the literature as to what constitutes inputs and outputs of a bank. Berger and Humphrey (1992) reviewed DEA efficiency studies on financial institutions and the various methods used to identify inputs and output variables. They identified three different groups of approaches in the empirical literature, namely *production (value added), intermediation (asset)* and *user cost (profit)* approaches, the most popular of which are the first two. Though both are derived from the neoclassical microeconomic theory of the firm applied to banking, they differ on what constitute the major role of a bank (Kumar and Gulati, 2008).

The production approach, pioneered by Benston (1965), perceives banks as production houses of services, including deposits and loans accounts, utilizing capital and labour. Hence outputs under this approach are measured by the number and type of accounts or transactions performed on deposits, loan services, and other specialized services. Usually, due to data limitations, the number of deposits and loan accounts are used as proxies for total services output of a bank. Inputs are defined by the components of total operating costs needed to generate and maintain the accounts. This approach does not include interest expenses as inputs.

The intermediation approach, on the other hand, considers banks as financial intermediaries that mobilize deposits and other liabilities to generate loans, securities and other interest earning assets. Thus loans and investments are considered as outputs whereas inputs include deposits and interest expenses in addition to operating costs.

Perhaps the most important difference between the production and the intermediation approaches can be derived from how bank deposits are treated. The former considers deposits as output while the latter treats deposits as an input. Nevertheless, irrespective of how deposit is treated it is important to state that production and intermediation approaches are alternative to each other and that they lead to different policy outcomes (Tortosa-Ausina, 2002). Moreover, even though Berger and Humphrey (1992) suggests that the intermediation approach is best suited for studying bank level efficiency rather than at branch level, they concede that neither the intermediation approach nor the production approach fully captures the dual role of a bank, namely as service provider and as financial intermediary. This observation suggests that the production approach must be seen as measuring how efficient a bank meets the service needs of its customers. The intermediation approach, however, may reflect how banks perform their traditional role as defined in the Keynesian macroeconomic theory, namely providing intermediation for effective use of national resources for growth.

However, commercial banks are profit making organizations just like other businesses in the product market. This means that efficiency assessment must recognize that banks have profit making objectives that may differ from that of customers or the regulator (Leithner and Lavell, 1998). The *profit approach* seeks to capture the profit maximization goal of banks. It is believe that the profit approach could help account for, not only the profit objectives of banks, but also the unmeasured changes in the quality of banking services that are reflected in pricing (Berger and Mester, (2003). Outputs under this approach include assets and liabilities that contribute to revenue whereas inputs are operational costs plus other assets and liabilities that contribute to cost. This approach differs from the previous two approaches in the way in which deposit is handled. Deposits are not considered as inputs since it is a function of labour and capital which are already included as inputs. Deposits are rather considered to have both expenditure and output characteristics. Leithner and Lavell (1998) argue that non-interest income captures the output aspect of deposits whereas the expenditure aspects are captured by interest expense component of net interest income and operational costs.

Because of the high sensitivity of efficiency scores to the selected set of inputs and outputs, it is common to find different combinations of input-output sets in a single study as a way of controlling for efficiency score sensitivity and for generating specific policy outcome. For example, Berger and Humphrey (1992, 1997) used different but overlapping sets of input-output variables that covered all the three approaches. Similarly, Drake et al. (2009) tests whether there are differences in the efficiency scores when the three alternative methodologies are used. They found significant evidence to accept the hypothesis. In the case of Ghana, however, only one input-output set was estimated by Korsah et al. (2001), using the production approach, Frimpong (2010) and Adjei-Frimpong (2014), both of which use the intermediation approach. Akoena et al (2009), on the other hand, estimated five (5) different sets of variables, four for intermediation approach and one for production approach. Though some of the input-output combinations overlap with the profit approach, the study did not explicitly capture the profitability objective of banks. Following Drake et al (2009), the current study improves literature on Ghana by utilizing all the three identified approaches to DEA in banking studies.

Drawing experience from past studies, the current study utilizes variations of all the three alternative theoretical approaches to selecting input-output in DEA on banking sector. Two sets of models are estimated for both the intermediation and the profit approaches, while a single model is estimated for production approach. The five models are listed in Table2. The variables are defined in Table 3.

Table 2: Selected Input-Output Variable for DEA on Ghanaian Banks

Approach		Output	Input
Intermediation	Model 1	Total Loans, Total Investments, Non-Interest Income	Total Operating Cost, Total Deposits, Total Provisioning
	Model 2	Net Interest Income, Non-Interest Income	Total Operating Cost, Total Deposits, Total Provisioning
Profit	Model 3	Net Interest Income, Non-Interest Income	Total Operating Cost, Total Provisioning
	Model 4	Total Investment, Total Loans	Total Operating Cost, Total Provisioning
Production	Model 5	Total Loans, Total Deposits, Non-Interest Income	Total Operating Cost, Interest Expenditure, Total Provisioning

Source: Author

f) Other Measurement Issues

Apart from considering which theoretical framework to use for selecting variables for the DEA analysis, several other important factors were considered in order to improve the accuracy of the estimated efficiency scores. Modern banks grow and compete by diversifying activities other than balance sheet activities. Berger and Mester (1997) emphasize the need to account for off-balance sheet activities that impact profitability of a diversified bank. Also, banks are expected to manage and incur risk as part of their activities. Failure to adequately account for risk in DEA is shown to have significant impact on the relative efficiency scores (Drake and Hall, 2003). According to Fare et al (2004), using bank equity as quasi-fixed inputs is sufficient to account for both risk-based and capital requirement and the risk-return trade-off that bank owners face. Akoena et al (2009) thus include equity as input in the intermediation model. Also, the importance of considering non-performing loan provisioning as a cost has been well articulated in the Bassel II accord for bank regulation. In view of this, Drake et al. (2009) included loan loss provisioning as input in all the three alternative theoretical approaches.

Another relevant consideration is that the choice of variable set should be consistent with the assumption that the set of DMU under study undertake homogeneous activities and have identical reporting formats (Korsah, 2001). Moreover, analyzing input variable sets with different correlation structures, Hassan (2008) establishes that omitting a relevant variable causes inconsistency in the efficiency scores and is worse when there is a negative correlation structure. This problem is identified especially for models that use input orientation. Hassan proposes the use of correlation test to select input variables that jointly ensure that relevant inputs have been exhaustively accounted for. Don and Param (2002) establish that efficiency scores are sensitive to including inappropriate variables and to unwittingly omitting important variables in the DEA model, especially in large samples and under different scale assumptions.

Table 3: Summary Statistics of Input-Output Variables (GH¢')

Variable	Definition	Mean	S.D	Max	Min
Total Loans	Loans, Overdrafts and Other advances	140,168,346	179,835,655	1,325,123,410	200
Total Deposits	Deposits from all private customers	219,809,674	288,703,243	2,047,607,321	76,105
Total Investments	stocks, bonds and other securities	80,323,195	126270265	1212993275	87035
Net Interest	Interest income less interest expenditure	3,726,305	7,006,509	106,189,000	3,122
Non-Interest Income	Fees, commissions and earnings other than interest income	2,623,720	6,246,148	156,096,844	282
Total Operating Cost	Expenditure on staff salary and other emoluments, training, occupancy, travels, administration and other operating expenses	3,366,431	66,59,140	99,420,500	32,727
Interest Expenditure	Interest expenses on all interest bearing liabilities	1,907,414	2,297,742	26,943,145	6
Total Provisioning	Provisions against bad debts, depreciation and other provisions required by regulation	2,033,577	22,045,117	679,635,000	636
Equity	Share holders' equity investment	40,512,319	52,942,840	622,648,998	7842

Source: Author's calculations

Finally, apart from the factors discussed previously, selecting variables as inputs or outputs is also dependent on data availability and whether variables are measured in currency units or in real units; for example, whether to use the number of accounts or the value of accounts (Tahir, et al., 2009). For the reasons that banks are multiservice firms that incur different costs on various accounts and mostly compete to increase their currency amount of market shares, Kolari and Zardkoohi (1987) advocate for currency units as the best common denominator for measuring inputs and outputs. Based on this consideration and for convenience, this study measures all variables in Ghanaian currency unit.

V. Empirical Results

a) *Industry Overall Technical Efficiency*

The LP(3), which assumes constant returns to scale, was run for all the five models in each quarter in order to measure the relative overall technical efficiency (OTE) for each of the banks that operated during that period. This means new and independent frontiers were estimated in each quarter. The mean OTE scores, covering all operating banks were calculated for each quarter and for each of the five models. Similarly, the percentage of the total number of banks that were OTE efficient in each period was derived from each model. Graphical presentations of the industry level results are shown in Figure1 while the numerical summary for the entire period are presented in Table 4.

Figure 1 show trends in the average OTE scores from each model. The trends were found to be negatively sloping for all models. This implies that the average intensity of overall technical efficiency declined during the study period. Similarly, the number of OTE efficient banks trended downwards, indicating that the prevalence of OTE inefficiency among banks generally increased over time. The empirical results were consistent for all the five models even though the level of severity varied among the models.

In terms of the number of banks that were OTE efficient, model 1 suggests that the highest number of

OTE efficient banks ever recorded in the entire period was about 77 per cent of the total number of banks. The average for the entire period, though, ranged between about 47 per cent (Model 1) and 24 per cent (Model 4). Especially, Model 4 suggests that, at some point in time, as many as about 94 per cent of the total number of banks in the industry were OTE inefficient. Therefore, results from the five models suggest that the prevalence of OTE inefficiency among the banks and during the study period ranged between 76 per cent and 53 per cent of the total number of banks in the industry. That is, more than 50 per cent of the banks were found to be OTE inefficient in almost each quarter of the period.

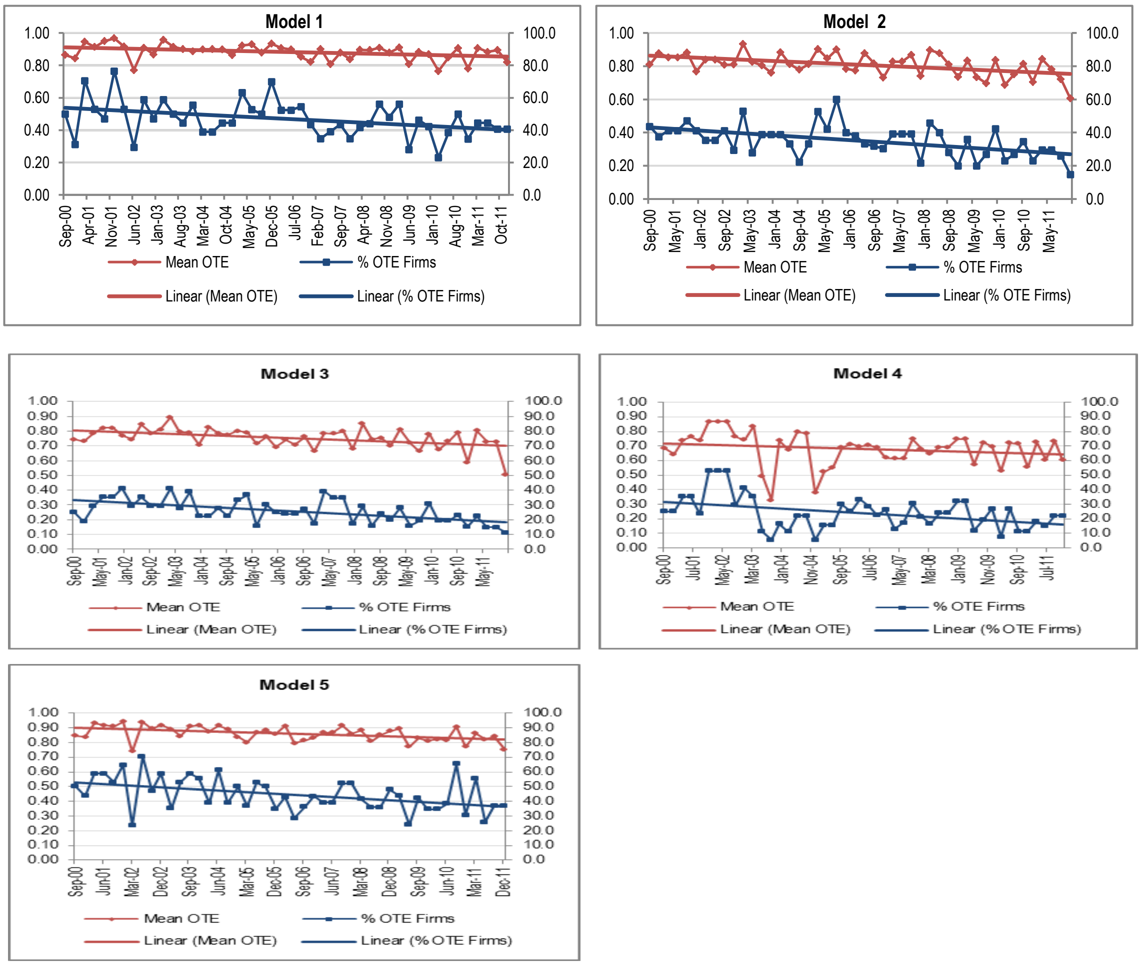

Figure 1: Evolution of Industry Overall Technical Efficiency (2000q3-2011q4)

Table 4: Summary of Industry Overall Technical Efficiencies (2000q3-2011q4)

	Mean	SD	Min	Max	$R_{OTE,PTE}$	$R_{OTE,SE}$
Model 1						
OTE Score	0.88	0.05	0.76	0.97	0.80	0.86
No of OTE Banks (%)	46.99	10.94	23.08	76.47	0.64	0.99
Model 2						
OTE Score	0.81	0.07	0.61	0.93	0.84	0.66
No of OTE Banks (%)	35.08	9.36	14.81	60.00	0.48	0.92
Model 3						
OTE Score	0.75	0.07	0.50	0.90	0.78	0.70
No of OTE Banks (%)	25.94	7.94	11.11	41.18	0.44	0.88
Model 4						
OTE Score	0.68	0.11	0.33	0.87	0.83	0.87
No of OTE Banks (%)	24.03	11.41	5.56	52.94	0.67	0.97
Model 5						
OTE Score	0.86	0.05	0.74	0.94	0.82	0.80
No of OTE Banks (%)	44.79	11.42	23.53	70.59	0.73	0.98

Source: Author's calculations

The overall results for sector OTE from the five models provide evidence to show that, both the level and the incidence of overall technical efficiency in the Ghanaian banking sector reduced during the period of study. The incidence of OTE inefficiency was found to dominate intensity of OTE inefficiency. At least a fifth of the banks were both scale and pure technically inefficient at each point in time. Irrespective of the choice of model, the results indicate that the level of OTE inefficiency was inefficient as low as 3 per cent below optimal capacity in some of the times, but was also as high as 67 per cent in other times. Though declining efficiency was consistent among the models, the steepness of the decline was sensitive to the choice of model. Model sensitivity of DEA was also established in Akoena et al (2009) and Drake et al (2009).

b) Industry Pure Technical Efficiency

As explained in the methodology, the overall technical efficiency or otherwise can be decomposed into two sources, namely pure technical efficiency (PTE) and scale efficiency (SE), though these components are non-additive. In order to obtain the PTE scores, LP (4) was run for all the five models and in each quarter. The results are reported in Table 5and Figure 2.

From the Figure, liner trends in all cases show that the averages PTE scores and the number of PTE efficient banks reduced over time, similar to those found for OTE. Table 5shows that the industry's average PTE inefficiency for the entire period ranged from about 5 per cent to 17 per cent with corresponding standard deviation range of 0.03 – 0.07 across the five models. The general conclusion here is that both the intensity and the incidence of pure technical efficiency all reduced during the study period. The results though were sensitive to the choice of model.

The average number of PTE inefficient banks ranged from a minimum of about 29 per cent by model 1 to a maximum of about 54 per cent by model 3, and with corresponding standard deviation range of 6.99 per cent and 9.75 per cent respectively. From all models, the industry pure technical efficiency was generally very high, almost at 100% at some points in time. For example, Model 1 estimated a maximum PTE score of 0.99. Yet, model 4 suggests that the level of inefficiency was sometimes as low as 45 per cent

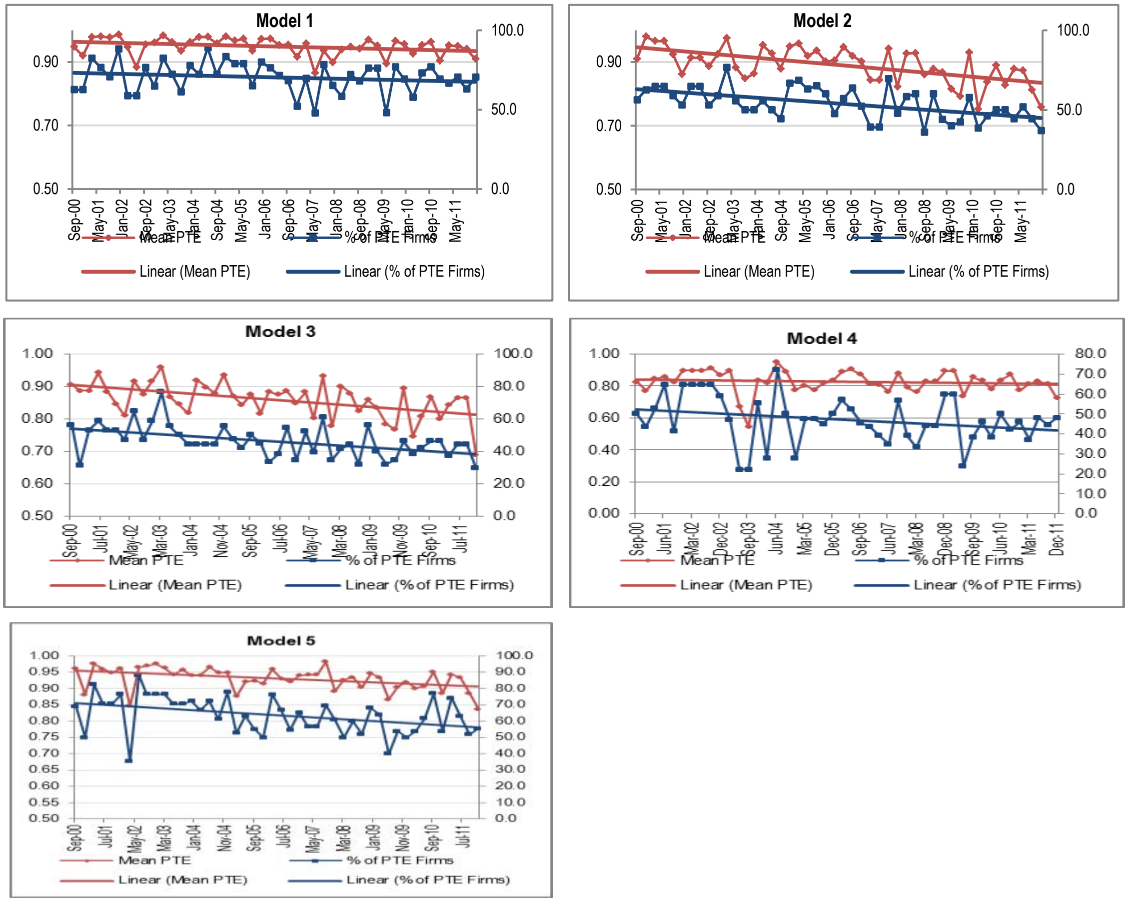

Figure 2: Evolution of Industry Pure Technical Efficiency (2000q3-2011q4)

Table 5: Summary of Industry Pure Technical Efficiencies (2000q3-2011q4)

	Mean	SD	Min	Max	$R_{OTE,PTE}$
Model 1					
PTE Score	0.95	0.03	0.87	0.99	0.39
No of PTE Banks (%)	70.33	9.48	47.83	88.89	0.64
Model 2					
PTE Score	0.89	0.06	0.75	0.98	0.16
No of PTE Banks (%)	53.99	9.87	36.00	76.47	0.48
Model 3					
PTE Score	0.86	0.05	0.69	0.96	0.78
No of PTE Banks (%)	46.20	9.75	29.63	76.47	0.44
Model 4					
PTE Score	0.83	0.07	0.55	0.95	0.83
No of PTE Banks (%)	46.90	11.89	22.22	72.22	0.67
Model 5					
PTE Score	0.93	0.03	0.84	0.98	0.82
No of PTE Banks (%)	63.44	11.39	35.29	88.24	0.73

Source: Author's calculations

c) *Industry Scale Efficiency*

Next, equation (5) was applied to the results from LP (3) and LP (4) to derive scale efficiency (SE) scores for the banks in each quarter. These are reported in Figure3 and Table6. Like previous results, the linear trends show that both the average SE efficiency scores and the number of SE efficient banks all reduced during the period. In particular, trends in the number of scale efficient banks were generally lower and associate with trends show that both the average SE efficiency scores and the number of SE efficient banks all reduced during the period. In particular, trends in the number of scale efficient banks were generally lower and associate with higher short term volatile in comparison with those of PTE.

From the Table, the average level of scale inefficiency in the industry over the entire period ranged from 7.0 per cent for Model 1 and 18 per cent for model 4. Additionally, the average number of banks that were SE inefficient ranged between about 52 per cent and about 75 per cent with standard deviation of 12.72 and 13.37 respectively.

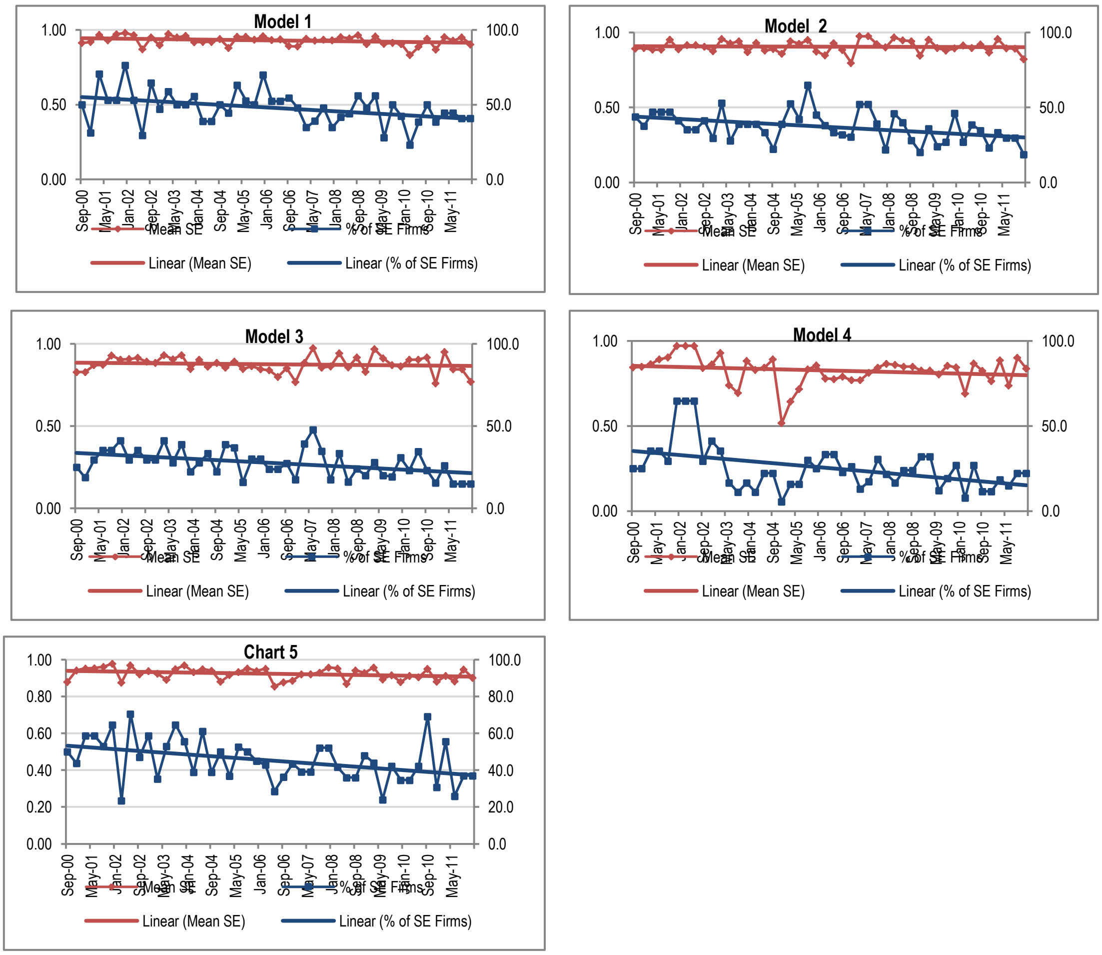

Figure 3: Evolution of Industry Scale Efficiency (2000q3-2011q4)

Table 6: Summary of Industry Scale Efficiencies (2000q3-2011q4)

		Mean	S.D.	Min	Max	$R_{OTE,SE}$	$R_{PTE,SE}$
Model 1							
	SE Score	0.93	0.03	0.83	0.98	0.35	0.11
	% of SE Firms	47.84	11.03	23.08	76.47	0.99	0.63
Model 2							
	SE Score	0.91	0.04	0.80	0.98	0.48	0.76
	% of SE Firms	36.99	10.01	18.52	65.00	0.92	0.37
Model 3							
	SE Score	0.88	0.05	0.76	0.97	0.70	0.11
	% of SE Firms	27.45	8.39	14.81	47.83	0.88	0.36
Model 4							
	SE Score	0.82	0.08	0.52	0.97	0.87	0.47
	% of SE Firms	25.27	13.37	5.56	64.71	0.97	0.59
Model 5							
	SE Score	0.92	0.03	0.86	0.98	0.80	0.32
	% of SE Firms	45.30	11.65	23.53	70.59	0.98	0.72

Source: Author's calculations

d) Industry Pure Technical Efficiency versus Scale Efficiency

Comparing the level of intensity between PTE and SE, it is not readily clear as to which of the two contributed more to the changes in industry OTE. From Table 5 and Table 6, Model 1 estimates an average PTE score of 0.95 against an SE average score of 0.93. Similarly, Model 4 and Model 5 estimate the average PTE score at 0.83 and 0.93 against SE scores of 0.82 and 0.92 respectively, all in favour of PTE. Thus these three models suggest that SE contributed more to the observed overall technical inefficiency. On the other hand, Models 2 and 3 recorded average PTE scores of 0.91 and 0.88 against SE scores of 0.89 and 0.86 respectively, all in favour of SE. Thus, the two models rather assume that PTE explains more of the observed bank OTE inefficiency. Therefore, it is not clear enough to determine from the mean efficiency scores as to which of the two sources best explains the observed changes in the sector OTE.

Also, correlation analysis between OTE and its two components could not help either. As shown earlier, the correlation results from models 1, 3 and 5 indicate stronger association between mean OTE scores and mean PTE scores. However, Model 2and Model 4 indicate stronger correlation between mean OTE scores and the mean SE scores. This lack of consensus among the five models, and even between models from the same theoretical approach, reflect the weakness in the use of mean scores for efficiency discrimination among firms over a considerable period of time. Arithmetic mean is known to be susceptible to extreme numbers. A graphical analysis indicated that PTE and SE dominated each other at different times, a situation the mean measure may have failed to properly account for.

Nevertheless, the clouds settle when the comparison is done using incidence of inefficiency rather than efficiency intensities. In all five cases, the number of banks that were PTE efficient was higher than for SE. That is, the observed decline in OTE occurred because there were more prevalent cases of SE inefficiency than the prevalence of PTE inefficiency among the banks. This conclusion is further corroborated by correlation analysis between incidence of OTE and its components. The correlation between the number of OTE efficient banks and the number of SE efficient banks were stronger than the correlation between the number of OTE and PTE efficient banks. Furthermore, the linear graphs for the number of PTE efficient banks lay above that for SE in all the five cases. Thus, the higher incidence of scale inefficiency must have contributed more to the observed OTE inefficiencies.

e) The Nature of Industry Scale Inefficiency

In order to determine whether the observed scale inefficiencies occurred because the banks were operating at increasing returns to scale (IRS) or decreasing returns to scales (DRS), LP (6) was run for all the five models in each quarter. The two types of inefficiencies cannot coexist in a bank but should be absent together if the bank is OTE efficient and hence operates at constant returns to scale. For each quarter, the number of banks that were scale inefficient was divided into cases of IRS and DRS. The results are shown in Figures 4 and Table 7.

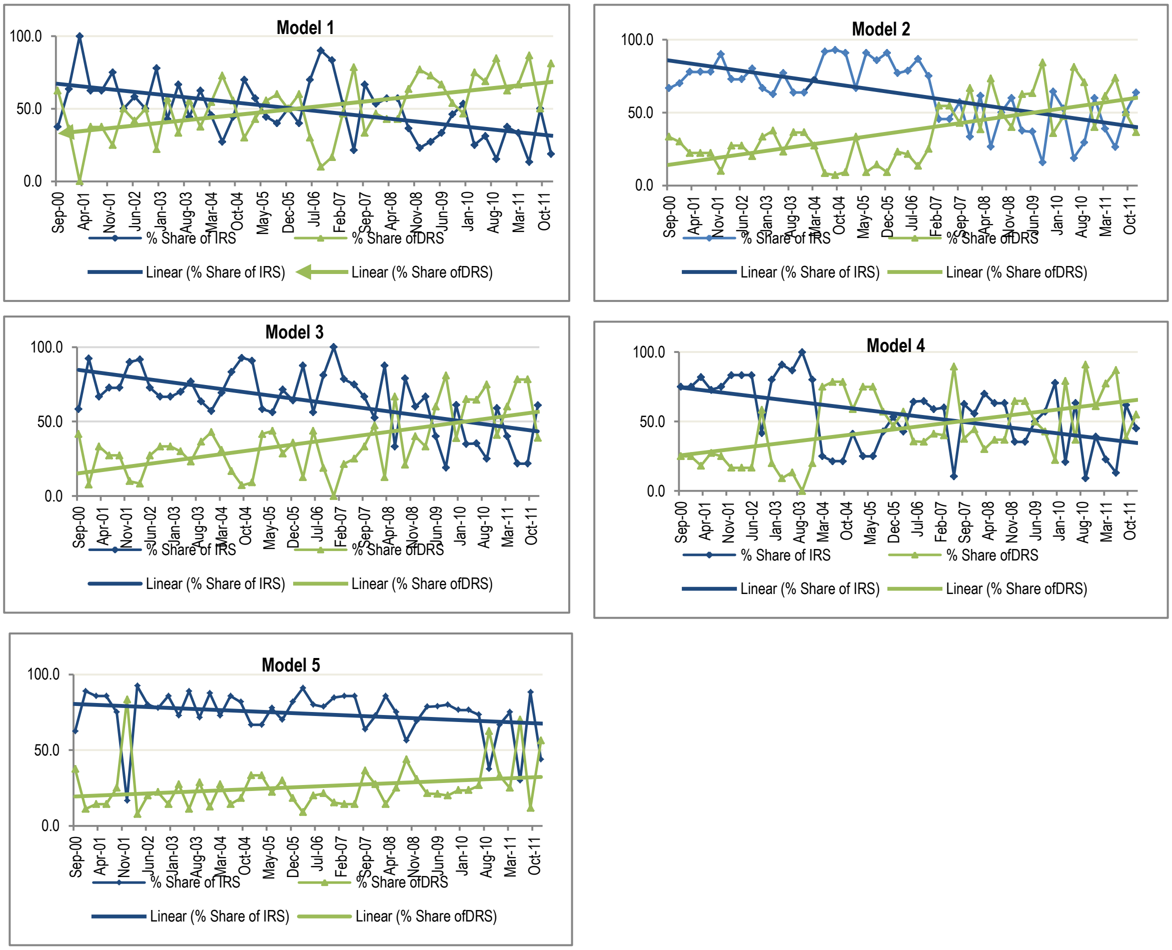

Figure 4: Changes in the Sources of Industry Scale Inefficiency (2000q3-2011q4)

Table 7: Nature of Industry Scale Inefficiencies (2000q3-2011q4)

	Mean	S.D.	Min	Max
Model 1				
Number of SIE Banks (%)	19.22	10.31	0.00	37.00
o/w Share of IRS in SIE	47.79	38.85	0.00	100.00
o/w Share of DRS in SIE	48.51	38.88	0.00	100.00
Model 2				
Number of SIE Banks (%)	23.11	10.59	2.00	40.00
o/w Share of IRS in SIE	61.30	33.66	0.00	100.00
o/w Share of DRS in SIE	38.70	33.66	0.00	100.00
Model 3				
Number of SIE Banks (%)	72.55	8.39	52.17	85.19
o/w Share of IRS in SIE	64.09	20.69	19.05	100.00
o/w Share of DRS in SIE	35.91	20.69	0.00	80.95
Model 4				
Number of SIE Banks (%)	74.48	13.31	35.29	94.44
o/w Share of IRS in SIE	54.56	24.18	9.09	100.00
o/w Share of DRS in SIE	45.44	24.18	0.00	90.91
Model 5				
Number of SIE Banks (%)	54.7	11.4	29.4	76.5
o/w Share of IRS in SIE	74.1	15.7	16.7	92.3
o/w Share of DRS in SIE	25.9	15.7	7.7	83.3

Source: Author's calculations Note: o/wimplies 'of which'

Observations from the charts reveal dynamic changes in the scale of operations in the Ghanaian banking industry. First, all the models indicate that the number cases of increasing returns to scale (IRS) reduced over time. On the other hand, cases of decreasing returns to scale (DRS) trended upward. This evidence implies that while the number of banks that were operating below their optimal scale was falling, banks that were operating at supernormal scale were increasing in number.

One possible reason could be due to the increased recapitalization requirements that were imposed on the banks on two separate occasions during the study period. It could also be due to the effects of market consolidation through mergers and acquisitions. Since the sizes of banks in the sector vary markedly, policies to expand the size of the industry, especially given the prevailing size of demand, may have pushed those that were too small in size towards their optimal levels but at the expense of driving the already large ones beyond their optimal scale.

The results in the Table show that, except model 1, the average percentage share of IRS in the total number of cases for scale inefficiencies was higher than that of DRS. The share of IRS in all cases of SE inefficiency ranged from 54.56 (model 4) to 74.1 per cent (model 5) of the total cases of scale inefficiency. It can also be observed from the Table that there were times when the shares were 100 per cent either because all the cases of scale inefficiencies were due only to IRS (models 1, 2, 3, and 4) or exclusively due to DRS (1, and 2). Model 5 estimated neither of such situations. Generally, though, the results indicate that the industry was scale inefficient because most of the scale inefficient banks operated below their optimal scale (IRS).

Secondly, IRS generally dominates DRS in the early part of the period. With time, however, DRS linear trends undercut and rise above IRS. The result for Model 5 was an exception. Yet it suffices to derive from here that the nature of the observed rising scale inefficiency in the Ghanaian banking sector changed in form from being IRS led to a dominant DRS situation. Also, reducing IRS and increasing DRS mean that relatively fewer and fewer of the banks were operating below their optimal scale while more and more were operating above their optimal scale in the course of time.

In all, the industry grew above its optimal scale. All things being equal, it may prove to be more prudent for future policy interventions to take other forms than to add to the number of banks, since the industry is growing above its optimal scale. Otherwise, any future expansionary policy should be targeted at expanding the size of those operating below their optimal scale rather than a blanket policy to all banks. Similar sentiment was expressed in Akoena et al (2009).This could help curb both IRS and DRS and hence help improve the overall technical efficiency in the sector.

VI. Conclusion

The empirical results in this study show that irrespective of the choice of model, industry overall technical, pure technical and scale efficiencies generally decreased over time. Based on this result, the study fails to accept the hypothesis that bank sector efficiency in Ghana improved over time. Specifically, the following conclusions are made from the empirical results on the evolution of bank sector efficiency in Ghana.

1. That the overall technical efficiency of the banking sector in Ghana reduced during the period.
2. That the reduction in the overall technical efficiency resulted from decline in both pure managerial efficiency (PTE) and scale efficiency (SE).
3. That compared to pure technical inefficiency, the level and prevalence of scale inefficiency was dominant among the banks during the period.
4. That the observed scale inefficiency was mainly due to the relatively high prevalence of increasing returns (IRS) to scale among the banks and in most of the time than for decreasing returns to scale (DRS).
5. That the number of cases of IRS reduced with time but at the expense of rising prevalence of decreasing returns to scale.

A key policy derivation from the study is that more attention needs to be given to helping banks to choose more appropriately their scale of operation. While some individual banks may need to expand further to achieve this, a blanket expansion policy, however, will be detrimental to the industry as a whole. Akoena et al (2009) alluded to a similar concern which the current study has provided additional evidence to support. With rising cases of decreasing returns to scale, blanket expansionary policy would increase the number of banks operating beyond their optimal scale. This and could increase losses in the market. Given that most of the banks operating at decreasing return to scale were relatively old and likely more reputed, blanket expansion could increase instability in the sector. A segmented market that allows banks to operate at more convenient capital outlay and hence more convenient scale may be one possible solution to the problem.

Though the universal banking policy has helped level the common playing field, it is also likely that the accompanied recapitalization requirements may have compelled some of the banks to expand their scale of operation beyond their optimal level. A policy which strategically segments the market to allow banks to choose just the appropriate scale for specific lines of business they have the most interest and expertise, while not compromising on competition, may help contain scale inefficiencies.

In particular, new entrant banks should be allowed to grow at a pace that commensurate with the range of banking businesses they believe to have the right expertise. Such banks should not be "forced" to start at too big a scale just to meet capital requirements that are needed for the complete range of banking business beyond what it is capable or within its immediate strategic plan. In some jurisdictions, segmenting the banking sector into national, regional, city and community banks could provide a more compact bouquet of services to meet the spectrum of consumers in Ghana.

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Appendices

Appendix 1: Detailed Results from model 1

Period	No of Banks	Mean Efficiency Scores			Number of Efficient Banks (% of total)			Sources of Scale Inefficiency (SIE)	
		OTE	PTE	SE	OTE Banks	PTE Banks	SE Banks	IRS (% of SIE)	DRS (% of SIE)
Sep-00	16	0.86	0.95	0.91	50.0	62.5	50.0	37.5	62.5
Dec-00	16	0.84	0.92	0.92	31.3	62.5	31.3	63.6	36.4
Mar-01	17	0.95	0.98	0.97	70.6	82.4	70.6	100.0	0.0
Jun-01	17	0.91	0.98	0.93	52.9	76.5	52.9	62.5	37.5
Sep-01	17	0.95	0.98	0.97	47.1	70.6	52.9	62.5	37.5
Dec-01	17	0.97	0.99	0.98	76.5	88.2	76.5	75.0	25.0
Mar-02	17	0.92	0.95	0.97	52.9	58.8	52.9	50.0	50.0
Jun-02	17	0.77	0.88	0.87	29.4	58.8	29.4	58.3	41.7
Sep-02	17	0.91	0.96	0.95	58.8	76.5	64.7	50.0	50.0
Dec-02	17	0.87	0.96	0.90	47.1	64.7	47.1	77.8	22.2
Mar-03	17	0.96	0.98	0.97	58.8	82.4	58.8	42.9	57.1
Jun-03	18	0.91	0.96	0.95	50.0	72.2	50.0	66.7	33.3
Sep-03	18	0.90	0.93	0.96	44.4	61.1	50.0	44.4	55.6
Dec-03	18	0.89	0.96	0.92	55.6	77.8	55.6	62.5	37.5
Mar-04	18	0.90	0.98	0.92	38.9	72.2	38.9	45.5	54.5
Jun-04	18	0.90	0.98	0.92	38.9	88.9	38.9	27.3	72.7
Sep-04	18	0.90	0.96	0.94	44.4	72.2	50.0	44.4	55.6
Dec-04	18	0.86	0.98	0.88	44.4	83.3	44.4	70.0	30.0
Mar-05	19	0.92	0.97	0.95	63.2	78.9	63.2	57.1	42.9
Jun-05	19	0.93	0.97	0.95	52.6	78.9	52.6	44.4	55.6
Sep-05	20	0.88	0.93	0.94	50.0	65.0	50.0	40.0	60.0
Dec-05	20	0.93	0.97	0.96	70.0	80.0	70.0	50.0	50.0
Mar-06	21	0.91	0.97	0.93	52.4	76.2	52.4	40.0	60.0
Jun-06	21	0.90	0.95	0.94	52.4	71.4	52.4	70.0	30.0
Sep-06	22	0.85	0.95	0.89	54.5	68.2	54.5	90.0	10.0
Dec-06	23	0.82	0.92	0.89	43.5	52.2	47.8	83.3	16.7
Mar-07	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Jun-07	23	0.81	0.87	0.93	39.1	47.8	39.1	21.4	78.6
Sep-07	23	0.88	0.94	0.94	43.5	78.3	47.8	66.7	33.3
Dec-07	23	0.84	0.90	0.93	34.8	65.2	34.8	53.3	46.7
Mar-08	24	0.90	0.94	0.95	41.7	58.3	41.7	57.1	42.9
Jun-08	25	0.89	0.95	0.94	44.0	72.0	44.0	57.1	42.9
Sep-08	25	0.91	0.94	0.97	56.0	68.0	56.0	36.4	63.6
Dec-08	25	0.88	0.97	0.91	48.0	76.0	48.0	23.1	76.9
Mar-09	25	0.91	0.95	0.96	56.0	76.0	56.0	27.3	72.7
Jun-09	25	0.81	0.89	0.91	28.0	48.0	28.0	33.3	66.7
Sep-09	26	0.88	0.97	0.91	46.2	76.9	50.0	46.2	53.8
Dec-09	26	0.87	0.96	0.91	42.3	69.2	42.3	53.3	46.7
Mar-10	26	0.76	0.93	0.83	23.1	57.7	23.1	25.0	75.0
Jun-10	26	0.85	0.95	0.89	38.5	73.1	38.5	31.3	68.8
Sep-10	26	0.91	0.96	0.94	50.0	76.9	50.0	15.4	84.6
Dec-10	26	0.78	0.90	0.87	34.6	69.2	38.5	37.5	62.5
Mar-11	27	0.91	0.95	0.95	44.4	66.7	44.4	33.3	66.7
Jun-11	27	0.88	0.95	0.93	44.4	70.4	44.4	13.3	86.7
Sep-11	27	0.89	0.94	0.95	40.7	63.0	40.7	50.0	50.0
Dec-11	27	0.82	0.91	0.90	40.7	70.4	40.7	18.8	81.3

Appendix 2: Detailed Results from model 2

Period	No of Banks	Mean Efficiency Scores			Number of Efficient Banks (% of total)			Sources of Scale Inefficiency (SIE)	
		OTE	PTE	SE	OTE Banks	PTE Banks	SE Banks	IRS (% of SIE)	DRS (% of SIE)
Sep-00	16	0.81	0.91	0.89	43.8	56.3	43.8	66.7	33.3
Dec-00	16	0.88	0.98	0.90	37.5	62.5	37.5	70.0	30.0
Mar-01	17	0.85	0.97	0.89	41.2	64.7	47.1	77.8	22.2
Jun-01	17	0.85	0.97	0.89	41.2	64.7	47.1	77.8	22.2
Sep-01	17	0.88	0.92	0.95	47.1	58.8	47.1	77.8	22.2
Dec-01	17	0.77	0.86	0.89	41.2	52.9	41.2	90.0	10.0
Mar-02	17	0.84	0.91	0.92	35.3	64.7	35.3	72.7	27.3
Jun-02	17	0.84	0.91	0.92	35.3	64.7	35.3	72.7	27.3
Sep-02	17	0.81	0.89	0.90	41.2	52.9	41.2	80.0	20.0
Dec-02	17	0.81	0.93	0.87	29.4	58.8	29.4	66.7	33.3
Mar-03	17	0.93	0.97	0.96	52.9	76.5	52.9	62.5	37.5
Jun-03	18	0.83	0.88	0.93	27.8	55.6	27.8	76.9	23.1
Sep-03	18	0.81	0.85	0.94	38.9	50.0	38.9	63.6	36.4
Dec-03	18	0.76	0.86	0.87	38.9	50.0	38.9	63.6	36.4
Mar-04	18	0.88	0.95	0.93	38.9	55.6	38.9	72.7	27.3
Jun-04	18	0.81	0.93	0.88	33.3	50.0	33.3	91.7	8.3
Sep-04	18	0.78	0.88	0.89	22.2	44.4	22.2	92.9	7.1
Dec-04	18	0.81	0.95	0.86	33.3	66.7	38.9	90.9	9.1
Mar-05	19	0.90	0.96	0.94	52.6	68.4	52.6	66.7	33.3
Jun-05	19	0.85	0.92	0.93	42.1	63.2	42.1	90.9	9.1
Sep-05	20	0.90	0.94	0.95	60.0	65.0	65.0	85.7	14.3
Dec-05	20	0.78	0.90	0.87	40.0	60.0	45.0	90.9	9.1
Mar-06	21	0.77	0.91	0.85	38.1	47.6	38.1	76.9	23.1
Jun-06	21	0.88	0.95	0.93	33.3	57.1	33.3	78.6	21.4
Sep-06	22	0.82	0.92	0.88	31.8	63.6	31.8	86.7	13.3
Dec-06	23	0.73	0.90	0.80	30.4	52.2	30.4	75.0	25.0
Mar-07	23	0.83	0.84	0.98	39.1	39.1	52.2	45.5	54.5
Jun-07	23	0.83	0.84	0.98	39.1	39.1	52.2	45.5	54.5
Sep-07	23	0.87	0.94	0.92	39.1	69.6	39.1	57.1	42.9
Dec-07	23	0.74	0.82	0.90	21.7	47.8	21.7	33.3	66.7
Mar-08	24	0.90	0.93	0.97	45.8	58.3	45.8	61.5	38.5
Jun-08	25	0.88	0.93	0.95	40.0	60.0	40.0	26.7	73.3
Sep-08	25	0.81	0.86	0.94	28.0	36.0	28.0	50.0	50.0
Dec-08	25	0.74	0.88	0.85	20.0	60.0	20.0	60.0	40.0
Mar-09	25	0.83	0.87	0.95	36.0	44.0	36.0	37.5	62.5
Jun-09	25	0.73	0.82	0.90	20.0	40.0	24.0	36.8	63.2
Sep-09	26	0.70	0.79	0.88	26.9	42.3	26.9	15.8	84.2
Dec-09	26	0.84	0.93	0.89	42.3	57.7	46.2	64.3	35.7
Mar-10	26	0.69	0.75	0.91	23.1	38.5	26.9	52.6	47.4
Jun-10	26	0.75	0.84	0.90	26.9	46.2	38.5	18.8	81.3
Sep-10	26	0.81	0.89	0.92	34.6	50.0	34.6	29.4	70.6
Dec-10	26	0.70	0.83	0.87	23.1	50.0	23.1	60.0	40.0
Mar-11	27	0.84	0.88	0.96	29.6	44.4	33.3	38.9	61.1
Jun-11	27	0.78	0.87	0.89	29.6	51.9	29.6	26.3	73.7
Sep-11	27	0.72	0.81	0.89	25.9	44.4	29.6	50.0	50.0
Dec-11	27	0.61	0.76	0.82	14.8	37.0	18.5	63.6	36.4

Appendix 3: Detailed Results from model 3

Period	No of Banks	Mean Efficiency Scores			Number of Efficient Banks (% of total)			Sources of Scale Inefficiency (SIE)	
		OTE	PTE	SE	OTE Banks	PTE Banks	SE Banks	IRS (% of SIE)	DRS (% of SIE)
Sep-00	16	0.74	0.91	0.83	25.0	56.3	25.0	58.3	41.7
Dec-00	16	0.73	0.89	0.83	18.8	31.3	18.8	92.3	7.7
Mar-01	17	0.79	0.89	0.87	29.4	52.9	29.4	66.7	33.3
Jun-01	17	0.82	0.94	0.87	35.3	58.8	35.3	72.7	27.3
Sep-01	17	0.82	0.88	0.93	35.3	52.9	35.3	72.7	27.3
Dec-01	17	0.77	0.85	0.90	41.2	52.9	41.2	90.0	10.0
Mar-02	17	0.74	0.81	0.91	29.4	47.1	29.4	91.7	8.3
Jun-02	17	0.84	0.92	0.92	35.3	64.7	35.3	72.7	27.3
Sep-02	17	0.79	0.88	0.89	29.4	47.1	29.4	66.7	33.3
Dec-02	17	0.81	0.92	0.88	29.4	58.8	29.4	66.7	33.3
Mar-03	17	0.90	0.96	0.93	41.2	76.5	41.2	70.0	30.0
Jun-03	18	0.79	0.87	0.91	27.8	55.6	27.8	76.9	23.1
Sep-03	18	0.79	0.85	0.93	38.9	50.0	38.9	63.6	36.4
Dec-03	18	0.71	0.82	0.85	22.2	44.4	22.2	57.1	42.9
Mar-04	18	0.83	0.92	0.90	22.2	44.4	27.8	69.2	30.8
Jun-04	18	0.78	0.90	0.86	27.8	44.4	33.3	83.3	16.7
Sep-04	18	0.78	0.88	0.88	22.2	44.4	22.2	92.9	7.1
Dec-04	18	0.80	0.94	0.85	33.3	55.6	38.9	90.9	9.1
Mar-05	19	0.79	0.87	0.89	36.8	47.4	36.8	58.3	41.7
Jun-05	19	0.71	0.84	0.85	15.8	42.1	15.8	56.3	43.8
Sep-05	20	0.76	0.88	0.86	30.0	50.0	30.0	71.4	28.6
Dec-05	20	0.69	0.82	0.85	25.0	45.0	30.0	64.3	35.7
Mar-06	21	0.74	0.88	0.84	23.8	33.3	23.8	87.5	12.5
Jun-06	21	0.71	0.88	0.80	23.8	38.1	23.8	56.3	43.8
Sep-06	22	0.76	0.89	0.85	27.3	54.5	27.3	81.3	18.8
Dec-06	23	0.66	0.85	0.77	17.4	34.8	17.4	100.0	0.0
Mar-07	23	0.78	0.88	0.88	39.1	52.2	39.1	78.6	21.4
Jun-07	23	0.78	0.80	0.97	34.8	39.1	47.8	75.0	25.0
Sep-07	23	0.80	0.93	0.86	34.8	60.9	34.8	66.7	33.3
Dec-07	23	0.68	0.78	0.86	17.4	34.8	17.4	52.6	47.4
Mar-08	24	0.85	0.90	0.94	29.2	41.7	33.3	87.5	12.5
Jun-08	25	0.74	0.88	0.86	16.0	44.0	16.0	33.3	66.7
Sep-08	25	0.75	0.82	0.92	24.0	32.0	24.0	78.9	21.1
Dec-08	25	0.70	0.86	0.83	20.0	56.0	20.0	60.0	40.0
Mar-09	25	0.81	0.83	0.97	28.0	40.0	28.0	66.7	33.3
Jun-09	25	0.72	0.78	0.91	16.0	32.0	20.0	40.0	60.0
Sep-09	26	0.66	0.77	0.87	19.2	34.6	19.2	19.0	81.0
Dec-09	26	0.78	0.90	0.86	30.8	46.2	30.8	61.1	38.9
Mar-10	26	0.67	0.75	0.90	19.2	38.5	23.1	35.0	65.0
Jun-10	26	0.73	0.81	0.90	19.2	42.3	34.6	35.3	64.7
Sep-10	26	0.79	0.87	0.92	23.1	46.2	23.1	25.0	75.0
Dec-10	26	0.59	0.80	0.76	15.4	46.2	15.4	59.1	40.9
Mar-11	27	0.80	0.84	0.95	22.2	37.0	25.9	40.0	60.0
Jun-11	27	0.73	0.86	0.84	14.8	44.4	14.8	21.7	78.3
Sep-11	27	0.73	0.86	0.84	14.8	44.4	14.8	21.7	78.3
Dec-11	27	0.50	0.69	0.77	11.1	29.6	14.8	60.9	39.1

Appendix 4: Detailed Results from model 4

Period	No of Banks	Mean Efficiency Scores			Number of Efficient Banks (% of total)			Sources of Scale Inefficiency (SIE)	
		OTE	PTE	SE	OTE Banks	PTE Banks	SE Banks	IRS (% of SIE)	DRS (% of SIE)
Sep-00	16	0.68	0.83	0.84	25.0	50.0	25.0	75.0	25.0
Dec-00	16	0.64	0.77	0.85	25.0	43.8	25.0	75.0	25.0
Mar-01	17	0.74	0.84	0.86	35.3	52.9	35.3	81.8	18.2
Jun-01	17	0.76	0.86	0.89	35.3	64.7	35.3	72.7	27.3
Sep-01	17	0.74	0.82	0.90	23.5	41.2	29.4	75.0	25.0
Dec-01	17	0.87	0.90	0.97	52.9	64.7	64.7	83.3	16.7
Mar-02	17	0.87	0.90	0.97	52.9	64.7	64.7	83.3	16.7
Jun-02	17	0.87	0.90	0.97	52.9	64.7	64.7	83.3	16.7
Sep-02	17	0.76	0.91	0.84	29.4	64.7	29.4	41.7	58.3
Dec-02	17	0.74	0.87	0.86	41.2	58.8	41.2	80.0	20.0
Mar-03	17	0.84	0.90	0.93	35.3	47.1	35.3	90.9	9.1
Jun-03	18	0.49	0.67	0.74	11.1	22.2	16.7	86.7	13.3
Sep-03	18	0.33	0.55	0.69	5.6	22.2	11.1	100.0	0.0
Dec-03	18	0.74	0.84	0.88	16.7	55.6	16.7	80.0	20.0
Mar-04	18	0.68	0.82	0.83	11.1	27.8	11.1	25.0	75.0
Jun-04	18	0.80	0.95	0.84	22.2	72.2	22.2	21.4	78.6
Sep-04	18	0.79	0.89	0.89	22.2	50.0	22.2	21.4	78.6
Dec-04	18	0.38	0.78	0.52	5.6	27.8	5.6	41.2	58.8
Mar-05	19	0.52	0.80	0.64	15.8	47.4	15.8	25.0	75.0
Jun-05	19	0.55	0.78	0.72	15.8	47.4	15.8	25.0	75.0
Sep-05	20	0.69	0.82	0.83	30.0	45.0	30.0	42.9	57.1
Dec-05	20	0.71	0.84	0.85	25.0	50.0	25.0	53.3	46.7
Mar-06	21	0.70	0.89	0.78	33.3	57.1	33.3	42.9	57.1
Jun-06	21	0.71	0.90	0.78	28.6	52.4	33.3	64.3	35.7
Sep-06	22	0.69	0.87	0.79	22.7	45.5	22.7	64.7	35.3
Dec-06	23	0.62	0.81	0.77	26.1	43.5	26.1	58.8	41.2
Mar-07	23	0.62	0.81	0.77	13.0	39.1	13.0	60.0	40.0
Jun-07	23	0.61	0.76	0.81	17.4	34.8	17.4	10.5	89.5
Sep-07	23	0.75	0.88	0.84	30.4	56.5	30.4	62.5	37.5
Dec-07	23	0.68	0.79	0.87	21.7	39.1	21.7	55.6	44.4
Mar-08	24	0.65	0.76	0.86	16.7	33.3	16.7	70.0	30.0
Jun-08	25	0.69	0.83	0.85	24.0	44.0	24.0	63.2	36.8
Sep-08	25	0.69	0.83	0.85	24.0	44.0	24.0	63.2	36.8
Dec-08	25	0.75	0.89	0.82	32.0	60.0	32.0	35.3	64.7
Mar-09	25	0.75	0.89	0.82	32.0	60.0	32.0	35.3	64.7
Jun-09	25	0.57	0.74	0.80	12.0	24.0	12.0	50.0	50.0
Sep-09	26	0.72	0.86	0.85	19.2	38.5	19.2	57.1	42.9
Dec-09	26	0.70	0.83	0.84	26.9	46.2	26.9	77.8	22.2
Mar-10	26	0.53	0.78	0.69	7.7	38.5	7.7	20.8	79.2
Jun-10	26	0.72	0.84	0.87	26.9	50.0	26.9	63.2	36.8
Sep-10	26	0.72	0.87	0.82	11.5	42.3	11.5	9.1	90.9
Dec-10	26	0.56	0.77	0.76	11.5	46.2	11.5	39.1	60.9
Mar-11	27	0.73	0.81	0.89	18.5	37.0	18.5	22.7	77.3
Jun-11	27	0.61	0.83	0.74	14.8	48.1	14.8	13.0	87.0
Sep-11	27	0.74	0.82	0.90	22.2	44.4	22.2	61.9	38.1
Dec-11	27	0.60	0.73	0.84	22.2	48.1	22.2	45.0	55.0

Appendix 5: Detailed Results from model 5

Period	No of Banks	Mean Efficiency Scores			Number of Efficient Banks (% of total)			Sources of Scale Inefficiency (SIE)	
		OTE	PTE	SE	OTE Banks	PTE Banks	SE Banks	IRS (% of SIE)	DRS (% of SIE)
Sep-00	16	0.85	0.96	0.88	50.0	68.8	50.0	62.5	37.5
Dec-00	16	0.84	0.88	0.94	43.8	50.0	43.8	88.9	11.1
Mar-01	17	0.93	0.98	0.95	58.8	82.4	58.8	85.7	14.3
Jun-01	17	0.92	0.96	0.95	58.8	70.6	58.8	85.7	14.3
Sep-01	17	0.91	0.95	0.96	52.9	70.6	52.9	75.0	25.0
Dec-01	17	0.94	0.96	0.98	64.7	76.5	64.7	16.7	83.3
Mar-02	17	0.74	0.85	0.88	23.5	35.3	23.5	92.3	7.7
Jun-02	17	0.94	0.96	0.97	70.6	88.2	70.6	80.0	20.0
Sep-02	17	0.89	0.97	0.92	47.1	76.5	47.1	77.8	22.2
Dec-02	17	0.92	0.98	0.94	58.8	76.5	58.8	85.7	14.3
Mar-03	17	0.89	0.96	0.92	35.3	76.5	35.3	72.7	27.3
Jun-03	18	0.84	0.94	0.89	52.9	70.6	52.9	88.9	11.1
Sep-03	18	0.91	0.96	0.95	58.8	70.6	64.7	71.4	28.6
Dec-03	18	0.92	0.94	0.97	55.6	72.2	55.6	87.5	12.5
Mar-04	18	0.88	0.94	0.93	38.9	66.7	38.9	72.7	27.3
Jun-04	18	0.92	0.97	0.95	61.1	72.2	61.1	85.7	14.3
Sep-04	18	0.89	0.95	0.94	38.9	61.1	38.9	81.8	18.2
Dec-04	18	0.84	0.95	0.88	50.0	77.8	50.0	66.7	33.3
Mar-05	19	0.80	0.88	0.92	36.8	52.6	36.8	66.7	33.3
Jun-05	19	0.87	0.92	0.93	52.6	63.2	52.6	77.8	22.2
Sep-05	20	0.88	0.92	0.95	50.0	55.0	50.0	70.0	30.0
Dec-05	20	0.86	0.92	0.94	35.0	50.0	45.0	81.8	18.2
Mar-06	21	0.91	0.96	0.95	42.9	76.2	42.9	90.9	9.1
Jun-06	21	0.79	0.93	0.86	28.6	66.7	28.6	80.0	20.0
Sep-06	22	0.81	0.92	0.88	36.4	54.5	36.4	78.6	21.4
Dec-06	23	0.83	0.94	0.89	43.5	65.2	43.5	84.6	15.4
Mar-07	23	0.87	0.94	0.92	39.1	56.5	39.1	85.7	14.3
Jun-07	23	0.87	0.94	0.92	39.1	56.5	39.1	85.7	14.3
Sep-07	23	0.92	0.98	0.93	52.2	69.6	52.2	63.6	36.4
Dec-07	23	0.86	0.89	0.96	52.2	60.9	52.2	72.7	27.3
Mar-08	24	0.88	0.93	0.95	41.7	50.0	41.7	85.7	14.3
Jun-08	25	0.81	0.93	0.87	36.0	60.0	36.0	75.0	25.0
Sep-08	25	0.85	0.90	0.94	36.0	52.0	36.0	56.3	43.8
Dec-08	25	0.88	0.95	0.93	48.0	68.0	48.0	69.2	30.8
Mar-09	25	0.89	0.93	0.96	44.0	64.0	44.0	78.6	21.4
Jun-09	25	0.77	0.87	0.89	24.0	40.0	24.0	78.9	21.1
Sep-09	26	0.83	0.91	0.92	42.3	53.8	42.3	80.0	20.0
Dec-09	26	0.81	0.92	0.88	34.6	50.0	34.6	76.5	23.5
Mar-10	26	0.82	0.90	0.91	34.6	53.8	34.6	76.5	23.5
Jun-10	26	0.82	0.91	0.90	38.5	61.5	42.3	73.3	26.7
Sep-10	26	0.91	0.95	0.95	65.4	76.9	69.2	37.5	62.5
Dec-10	26	0.77	0.89	0.88	30.8	53.8	30.8	66.7	33.3
Mar-11	27	0.86	0.94	0.91	55.6	74.1	55.6	75.0	25.0
Jun-11	27	0.82	0.93	0.88	25.9	63.0	25.9	30.0	70.0
Sep-11	27	0.84	0.89	0.95	37.0	51.9	37.0	88.2	11.8
Dec-11	27	0.75	0.84	0.90	37.0	55.6	37.0	43.8	56.3

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