Investigating the Market-Structure - Performance Relationship in the Commercial Banking Sector: Evidence from Jamaica

Sherene A. Bailey[1]
Financial Stability Department
Bank of Jamaica

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Abstract

This paper employs a two-stage estimation procedure to evaluate the impact of bank concentration on performance. In the first stage of the estimation process, a stochastic cost frontier is estimated for the dominant commercial banks in Jamaica over the period 1989 – 2005, using both translog and Cobb-Douglas cost functions. The translog cost frontier model was found to be a more appropriate fit for the data. As such, efficiency estimates from this cost frontier model served as endogenous inputs in the second stage of the estimation procedure, where a VAR framework was employed to investigate the relationship between efficiency, concentration, and performance in the industry. The findings from the paper suggest that, on average, dominant banks in the industry would only need to reduce costs by 7.0 per cent in order to operate as efficiently as possible. Results from the VAR framework reject the structure-market-performance hypothesis. Rather, improvements in efficiency contribute to increased profitability for the dominant banks. However, improvements in efficiency for these dominant banks may not be reflected in their pricing policies due to the absence of strong competition in the sector. As such, there is further scope for initiatives geared at lowering interest margins and stimulating growth in the wider economy.

JEL Classification Numbers: C61; G21; L25
Keywords: Market structure; stochastic frontier; efficiency

[1] The views expressed are those of the author and do not necessarily reflect those of The Bank of Jamaica.

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1. INTRODUCTION

The Jamaican commercial banking sector underwent significant structural changes subsequent to the period of financial sector distress during the late 1990s. This period of reform engendered changes in the ownership structure and the degree of concentration within the sector. At the start of the crisis period in 1996, there were nine banks in operation, however, this number declined to six at the end of the crisis period in 1999. A previous study on the impact of increased concentration on competition in the banking system, found that there was declining competition over the period 1988 to 2002.[2] However, the nature of the relationship between concentration and performance in the sector remains unexplored.

Proponents of the structure-conduct-performance (SCP) hypothesis posit that market players in concentrated industries have the capacity to raise prices through monopolistic conduct and that these firms may gain large market shares and earn supernormal profits. At the same time, increased profitability may be evidence of increased efficiency within an industry due to lower costs of production, enabling some firms to compete more aggressively and capture a bigger market share. Since the consolidation in the sector subsequent to the crisis period, intermediation margins have fluctuated within a band of 10.0 per cent to 15.0 per cent, despite the trend decline in policy rates since 2000. This has raised concerns for policymakers and has resulted in various efforts to increase competition in the sector.

It is important to note that the alternative hypotheses have opposing policy implications. If banks' profitability were driven by increased concentration, regulators would find it beneficial to enforce antitrust regulation to move prices towards competitive levels and allocate resources more efficiently. Alternatively, if greater profitability is attributable to increased efficiency, then regulation geared at dismantling efficient firms and/or preventing mergers may raise costs and lead to less favourable prices for consumers. As such, the paper explores whether reductions in domestic interest rates should be

[2] See Duncan (2002)

accompanied by reforms such as the reduction of entry barriers in order to improve the competitive structure in the commercial banking sector.

The link, if any, between market concentration and bank performance received considerable attention during the 1990s, given substantial financial sector consolidation across a large number of industrialized countries. Regulators in concentrated markets have been faced with the issue of determining whether profitability is influenced by increased efficiency or the monopolistic behaviour of the more dominant market players and the resulting implications for consumer welfare. Civelek and Al-Alami (1991) noted that the banking sector is important to the economy and hence empirical evidence on the concentration-performance relationship can inform regulatory policies that govern the banking system. Increasing banking sector concentration may raise the cost of funds, thereby reducing the level of intermediation in the economy and impairing economic growth.

The issues outlined above raises an important policy question: Did the increased concentration in the sector beginning in the latter part of the 1990s lead to reduced efficiency and increased profitability in the sector? As such, the purpose of the empirical investigation is two-fold. First, efficiency estimates are derived for dominant banks in the Jamaican banking sector.[3] Second, these estimates are employed, through a VAR framework, in assessing the concentration-performance relationship in the banking sector. The results of the study will inform the direction of policy for the commercial banking sector as it relates to the safeguarding of consumer welfare and regulating competition within the sector in order to engender lower costs for bank services.

[3] The dominant banks used in the study are the two largest commercial banks.

The paper is organized as follows: Section 2 examines the theoretical underpinnings of the link between market concentration and performance. Section 3 provides a brief outline of the structure-performance relationship in the commercial banking sector. Section 4 discusses the methodology and the data employed. Section 5 presents the findings of the model. The policy implications of the results and the conclusion are outlined in section 6.

2. Previous Literature

2.1 The Relationship between Market Structure and Performance

Evaluating bank performance is a complex process that involves assessing the interaction between a bank's internal operations and external environment. An important aspect of the assessing the impact of the external environment is by examining the influence of market structure on bank performance. The relationship between market structure and bank performance has been examined at length in the literature, particularly by assessing the implications of industry concentration for operational efficiency in the sector. The relationship between industry concentration and commercial bank profitability or performance is explained by two contrasting hypotheses. Alternative explanations provided by the traditional SCP hypothesis and efficient market hypothesis (EMH), give insight on the direction and nature of this relationship.[4]

Proponents of the traditional paradigm posit that there is a one-way relationship between concentration and profitability, due to the fact that market concentration lowers the cost of collusion between firms, influencing increases in prices and higher than normal profits.[5] The key issue here is that higher seller concentration fosters explicit collusion on the part of firms, allowing all firms in the market to earn monopoly rents. This suggests that where markets are conducive to monopolistic conduct, due to barriers to entry and market concentration, firms have greater autonomy to raise prices above their costs, resulting in excess profits. As a consequence, the leitmotiv of the traditional

[4] The structure-conduct-performance theory is also known as the collusion hypothesis.
[5] See Chirwa (2003).

paradigm is that market structure influences bank performance through the institution's pricing policy or pricing behaviour. The theoretical implication of the traditional framework is that in concentrated markets consumers face less favourable prices due to the non-competitive behaviour that generally exists in these markets. Hence, lower levels of profitability are anticipated in markets where there is perfect demand elasticity compared to all other markets. Berger and Hannan (1989) posit that if the SCP hypothesis reflects anti-competitive pricing, then banks will be able to charge lower deposit rates and/or higher loan rates.[6]

This relationship has been widely tested in the field of industrial economics. Bain (1951) found evidence of a positive and significant relationship between concentration and profitability based on US manufacturing data. However, later studies using banking sector data have revealed mixed results. The specification of the SCP model in banking is based on a profit-concentration relationship that is defined as follows[7]:

$$\pi_i = f(CR, X_i) \tag{1}$$

where, π_i, is a profit measure of the i_{th} bank, this can be captured by the rate of return on capital or assets (ROC or ROA), CR, is the banks' index of concentration and X_i, denotes a vector of control variables that account for firm-specific and market-specific characteristics which affect prices through market or cost considerations. The mixed empirical results on the SCP model have undermined the importance of the model in explaining bank behaviour.

The EMH emerged from criticism of the traditional paradigm. Rather than being a random event, the efficiency theory bases increased market concentration on the superior productivity or efficiency of the leading firms. This occurs because increased productivity and profitability enables firms to offer competitive rates on loans and/or deposits, inducing them to gain larger market shares and further increase profitability.

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[6] See Goldberg & Rai (1996)
[7] See Chirwa (2001)

According to the EMH, firm-specific efficiencies encourage unequal market shares and high levels of concentration.

Molyneux & Forbes (1995) and Smirlock (1985) posited that the EMH is specified as a market share – profitability relationship. The market share variable captures firms' superior efficiency in obtaining a larger portion of the market and equation (1) is re-specified as follows:

$$\pi_i = f(CR, MS, X_i) \tag{2}$$

Tests of both hypotheses are captured in equation (3):

$$\pi_i = \beta_0 + \beta_1 CR + \beta_1 MS + \sum_{i=1}^{m} \alpha_1 X_i \tag{3}$$

where the significance of MS in equation (3) would imply support for the efficient structure hypothesis; while the significance of the concentration ratio would support the traditional hypothesis. However, Berger and Hannan (1993) have argued that the validity of the market share variable in testing for efficiency is dependent on whether the variable can be considered as a proxy for the efficiency of larger firms rather than as measure of market power. Given the spurious nature of this relationship, empirical findings based on these two market structure-performance hypotheses have been inconclusive.

The Berger & Hannan Model

Berger & Hannan (1993) developed a model to directly include efficiency in examining the relationship between market structure and performance. The model captures efficiency from two perspectives: Scale efficiency and X-efficiency. A simultaneous test of the competing hypotheses is presented in equation (4).

$$P_i = f(X - EFF_i, S - EFF_i, CONC_m, Z_i) + e_i \tag{4}$$

where, P_i, represents measures of firm performance, $X - EFF_i$ *and* $S - EFF_i$, represent measures of technical efficiency and scale efficiency, respectively, and, Z_i, is a vector of control variables. The scale efficiency version of the efficient structure hypothesis indicates that some firms produce at a more efficient scale than others, which could result in lower interest margins and increased market shares. This measure captures whether the banking firm operates at an optimal scale of production at which the per unit average production cost is minimized.

Under the X-efficiency hypothesis, it is important to determine whether a firm is producing as efficiently as it can, given its size. Hence, firms with superior management or production processes can operate at lower costs and subsequently reap higher profits. This encourages growth in market share and fuels increased industry concentration.

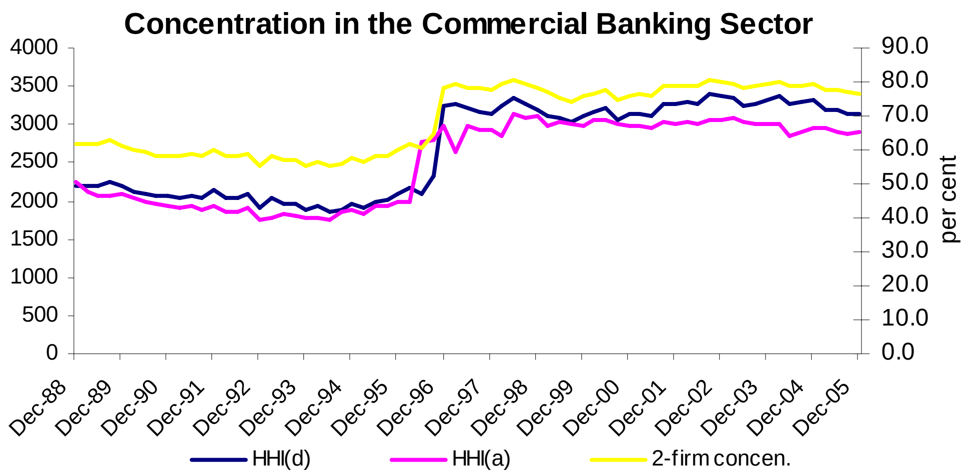
Generally, empirical studies on bank efficiency revealed that X-efficiency is more important in explaining differences in bank costs than scale efficiencies (see Berger, Hunter, and Timme 1993). As such, the paper focuses solely on X-efficiency estimates in investigating the relationship specified in equation (4). The methodology for deriving efficiency estimates is discussed in section 4.

3.0 Developments in Concentration & Performance in the Commercial Banking Sector: 1988 - 2005

The process of economic liberalization in the Jamaican economy during the late 1980s and early 1990s engendered structural changes involving the deregulation of the financial sector. This process of reform led to rapid expansion in the number of commercial banks in the industry due to the liberalization of licensing requirements in the sector. Against this background, there was a marked decline in concentration in the sector, as measured by the Herfindahl - Hirschman index (HHI) and the two-firm concentration ratio (see Figure 1).[8]

[8] The Herfindahl-Hirschman index is a widely used measure of concentration. It is computed as the sum of all the banks' squared market shares, where market share is based on either deposits or assets, while the two-firm concentration ratio is represented as the per cent of deposits held by the two most dominant banks. Return on assets is utilized as an overall measure of performance and is captured by net profits as a proportion of average total assets.

Figure 1



The concentration indices were computed on a quarterly basis over the period March 1988 – December 2005 and displayed a similar pattern during this period (see Figure 1). The movement in these indices was primarily driven by the performance of the two most dominant banks, as the two-firm concentration ratio exceeded industry concentration for most of the sample period (see Figure 1). This implies that industry concentration was largely influenced by the duopolistic behaviour present in the industry.

The decline in the HHI that was observed during the liberalization era continued into the 1992 – 1995 post-liberalization period (see Figure 1). The HHI (deposits) fell to a low of 1 857 at end June 1994, from approximately 2 185 at the end of 1989, representing a 15.0 per cent decline over this period. The profitability of the dominant market players was inversely related to industry concentration during this period.

Figure 2

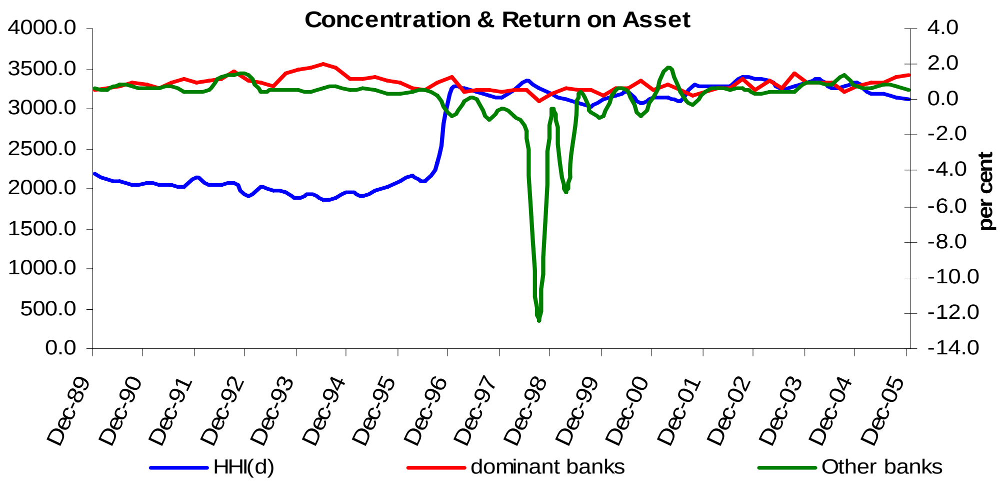


Figure 2 shows that for the similar period, the ROA of the two most dominant banks increased from 0.6 per cent to a high of 2.0 per cent. This contradicts the findings of the structuralist theory, which is suggestive that a decline in concentration is associated with reduced profitability for the dominant banks.

Rather, this improvement in performance is suggestive of reductions in the costs of production and increases in productivity of the dominant banks due to the increased competition in the sector. Figures 3 & 4 also show that the improvement in the ROA of these banks was driven by strong increases in net interest margin and non-interest income as a proportion of total assets during the post-liberalization period. This occurred relative to much weaker growth in operating expenses as a proportion of assets. In fact, operating costs as a proportion of average total assets were relatively stable averaging 4.0 per cent over the period 1992 to 1995.

Figure 3

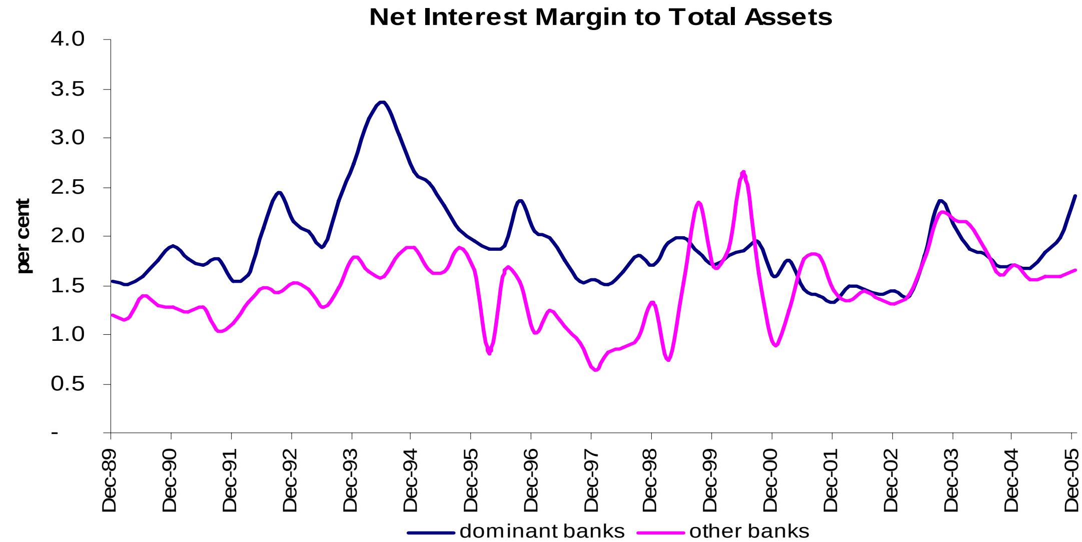
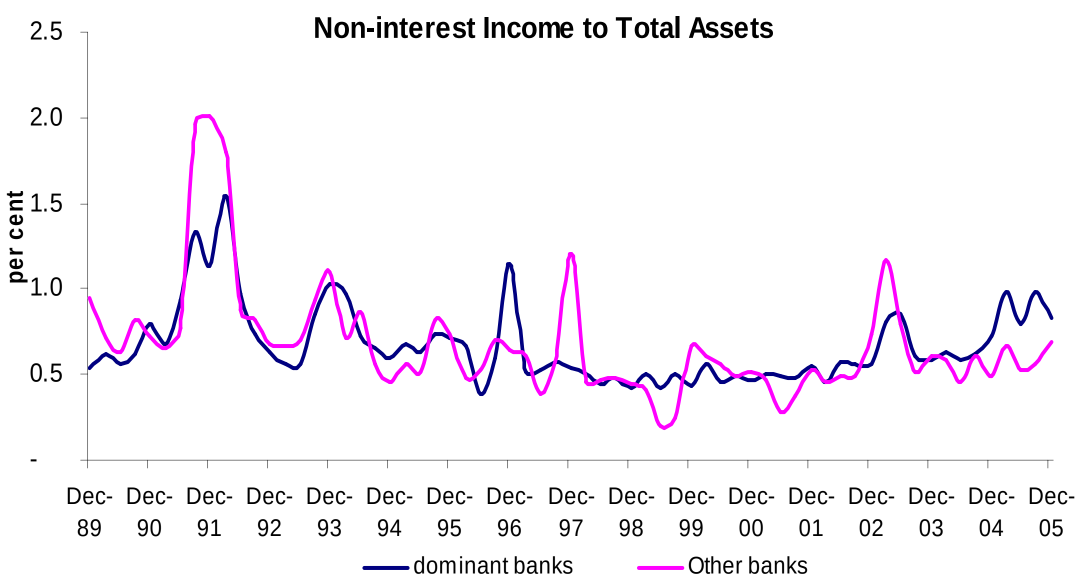


Figure 4



The containment in operating costs as a proportion of total assets was reflective of a moderation in the growth of interest costs (see Figures 5 & 6).

During the crisis period of the late 1990s, the return on assets for the dominant banks averaged 0.6 per cent relative to an average ROA of negative 1.5 per cent for the other banks over the period. There was also a slower pace of growth in operating expenses as a proportion of average total assets relative to other banks during the period of distress. Nonetheless, this performance was largely due to greater efficiency in the operations of one dominant bank.

Figure 5

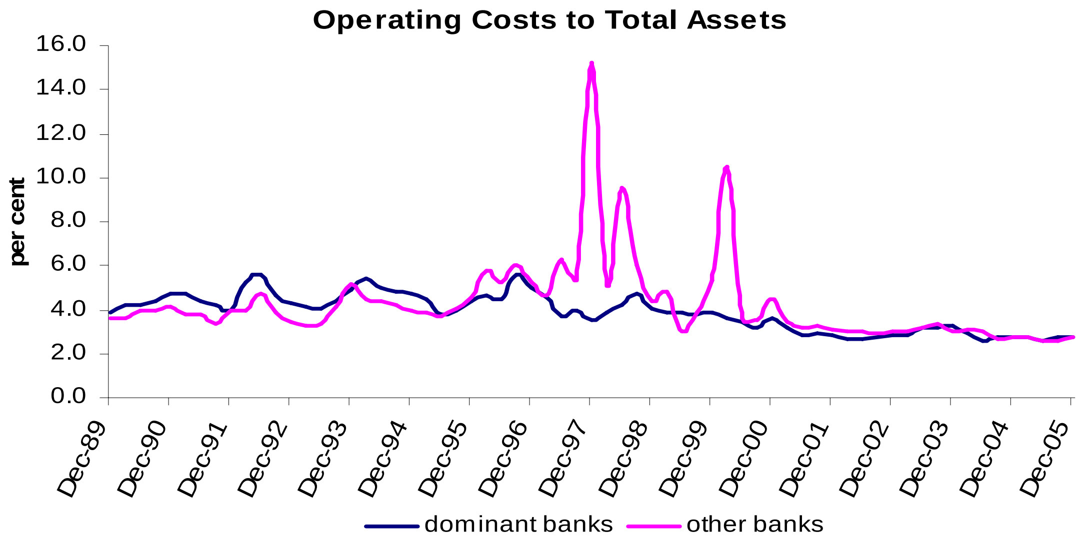
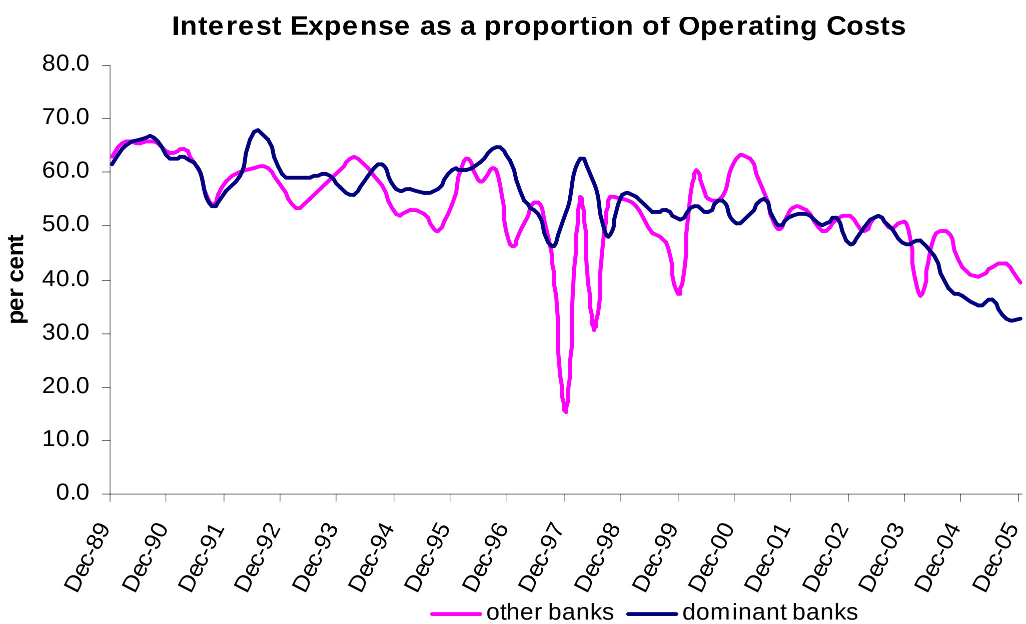


Figure 6



Subsequent to the distress period, there was substantial consolidation in the sector following the restructuring of a number of failed banks.[9] Against this background, the HHI increased to an average of 3241.4 for the post-crisis period of 2000 to 2005 relative to an average of 2999.6 during the crisis period (see Table 1). At the same time, the ROA and NIM of the dominant banks reflected respective averages of 0.8 per cent and 1.7 per cent during the post-crisis period relative to 0.6 per cent and 1.2 per cent during the crisis period. Additionally, there was a positive, albeit marginal, correlation between the HHI index and the NIM of the dominant banks during 2000 to 2005 (see Table 1). This performance is somewhat consistent with the structuralist theory, which indicates a positive association between concentration and profitability. Nonetheless, the improvement in performance of the dominant banks could be reflective of improvements in efficiency relative to the crisis period, which would imply support for the EMH.

Therefore, despite the positive relationship between concentration and performance during this period, the exact nature of this relationship remains uncertain. This underscores the relevance of explicitly accounting for efficiency, in order to ascertain a more precise relationship between concentration and performance.

Table 1.0 - Mean Performance Ratios (per cent) & Concentration Measures: 1989 - 2005

Sub-Periods	***1989 - 1991***	***1992 - 1995***	***1996 - 1999***	***2000 - 2005***
Concentration				
HHI - deposits	2 118.2	1 969.9	2 999.6	3 241.4
Performance				
ROA	0.8	1.3	0.6	0.8
NIM to total assets	1.2	1.6	1.2	1.7
Correlation				
HHI & ROA	-0.6	-0.5	-0.3	-0.1
HHI & NIM to total assets	-0.1	-0.4	-0.2	0.1

[9] The restructuring process was spearheaded by the Financial Sector Adjustment Company (FINSAC), which was established by Government in 1997 to resolve the difficulties in the financial sector.

4. Methodology & Data

4.1 Measures of Efficiency

4.1.1 Technical Efficiency

Technical efficiency or X-efficiency is a measure of how effectively banks utilize inputs to produce a given level of output. The bank's effectiveness in achieving the optimal mix of cost-minimizing inputs can be specified by an efficient cost frontier. Given the likelihood of bank-by-bank deviations in the efficient cost frontier, it is necessary to specify a stochastic cost function. As such, this paper employs the stochastic cost frontier proposed by Aigner et al. (1977), where deviations from the efficient cost frontier are captured by a random noise, v_i, and an inefficiency component, u_i.[10]

The cost function is represented as:

$$\ln tc = f(y_i, p_i) + \varepsilon_i \qquad (5)$$

where $\varepsilon_i = u_i + v_i$, y_i, is the output i of each bank, p_i, is the cost of input i and, v_i, is statistical noise distributed normal $(0, \sigma_2)$.[11] U_i is a an inefficiency measure which can follow a truncated or half-normal distribution and measures the individual firm's deviation from the efficient cost frontier, due to non-optimal employment of the quantity or mix of inputs given their prices as a result of management errors. This variable is referred to as 'technical inefficiency'. However, it relates to both technical inefficiencies from using too much of the inputs to produce the same output and allocative inefficiencies from failing to react optimally to the relative prices of inputs. The variable v_i is an exogenous component which is due to data or measurement error or unexpected and uncontrollable factors such as labour strikes and war that are not under the influence of management.

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[10] Aigner et al. utilized the approach to investigate cost efficiencies.
[11] Maximum likelihood estimation techniques are utilized in estimating the coefficients.

Estimates of u_i or technical inefficiency are derived from the stochastic frontier for each bank. In investigating the concentration-performance relationship outlined in equation 4, u_i is substituted for the efficiency variable, X-EFF. The predicted relationship between u_i and profitability is negative when the performance measure is defined by the return on assets, since lower inefficiency is associated with larger profits. While for the net interest margin, the relationship is positive since higher inefficiency implies a larger net interest margin.

The log-likelihood function for equation (5) is specified as:

$$\ln L = \frac{N}{2}\ln\frac{2}{\pi} - N\ln\sigma - \frac{1}{2\sigma^2}\sum_{i=1}^{N}\in_i^{\,2} + \sum_{i=1}^{N}\ln\left[\psi\left(\frac{\in_i \lambda}{\sigma}\right)\right] \tag{6}$$

with N denoting number of banks and ψ is the standard normal cumulative distribution. Equation (8) shows that the ratio of variability, σ, can be used to measure a firm's mean inefficiency by:

$$E(u_i / \in) = \left[\frac{\sigma\lambda}{1+\lambda^2}\right]\left[\frac{\phi(\in_i \lambda/\sigma)}{\psi(\in_i \lambda/\sigma)} + \frac{\in_i \lambda}{\sigma}\right] \tag{8}$$

where $\sigma^2 = \lfloor \sigma_u^{\,2} + \sigma_v^{\,2} \rfloor$, $\lambda = \sigma_u / \sigma_v$, and $\phi(\cdot)$ is the standard normal density function.

This paper employs two variations of the model specified in equation (5), in estimating a cost frontier for banks in Jamaica. A translog cost function is considered because of its flexibility in allowing for input substitutability (see equation (9)) as well as a simpler Cobb-Douglas cost function which is specified in equation (10).

$$\ln tc = \alpha_0 + \sum_{i-1}^{2}\alpha_i \ln(y_i) + \sum_{j=1}^{3}\beta_j \ln(p_j) + 1/2\sum_{i=1}^{2}\sum_{k=1}^{2}\alpha_{ik}\ln(y_i)\ln(y_k) + 1/2\sum_{j=1}^{3}\sum_{h=1}^{3}\beta_{jh}\ln(p_j)\ln(p_h)$$
$$+ 1/2\sum_{j=1}^{3}\sum_{h=1}^{3}\beta_{jh}\ln(p_j)\ln(p_h) + \sum_{i=1}^{2}\sum_{j=1}^{3}\delta_{ij}\ln(y_i)\ln(p_j) + \in \qquad (9)$$

$$\ln tc = \beta_0 + \beta_1 \ln(y_{1it}) + \beta_2 \ln(y_{2it}) + \beta_3 \ln(p_{1it}) + \beta_4 \ln(p_{2it}) + \beta_5 (p_{3it}) + (u_{it} + v_{it}) \qquad (10)$$

where the subscripts i and t refer to the i^{th} bank and the t^{th} period.

In both models, the term, U_i, represents non-negative random variables that are assumed to be independently distributed as truncations of the $N(\delta Z_{it}, \sigma_u{}^2)$ distribution, where Z_{it} are factors that affect firm efficiency, while δ is a vector of parameters to be estimated. As a consequence, inefficiency is modelled using the auxiliary model specified in equation (11).

$$U_{it} = Z_{it}\delta = \delta_0 + \delta_1 z_{1it} + \delta_2 z_{2it} + w_{it} \qquad (11)$$

where z_1 = total assets and z_2 = return on assets

Additionally, for the two models considered, TC represents total operating and interest costs. Two outputs are employed in the model; loans, which is the primary output, y_1, and all other earning assets, y_2, is included as a secondary output. There are three inputs, with prices defined as the price of labour, p_1, price of fixed capital, p_2, and borrowed funds, p_3. P_1 is defined as personnel expenses divided by total assets, P_2 is defined as capital and occupancy expenses divided by fixed assets, and P_3 is defined as total interest expenses divided by interest bearing liabilities. Consistent with linear homogeneity conditions, TC and the prices of all inputs are normalized by the price of labour ($p1$). Therefore, the transformed variables are denoted as TC^*, $p_2{}^*$ and $p_3{}^*$.

The cost functions defined by equations (9) and (10) are estimated using FRONTIER®, an econometric software package designed to provide maximum likelihood estimates of a variety of stochastic frontiers.[12] FRONTIER follows a three-step estimation procedure. First, ordinary least squares (OLS) estimates of the function are obtained as starting values. Next, a two-phase grid search is conducted to refine the starting values. [13] Final estimates are obtained iteratively using the Davidson, Fletcher, and Powell Quasi-Newton Method. Cost efficiency estimates derived from the model range over the interval $[1, \infty]$, with a score of one indicating full efficiency, which means that the firm is operating on its efficient cost frontier. The amount by which the score deviates from 1 is a measure of technical inefficiency.

4.2 Data

The model utilizes quarterly commercial banking system data covering the period March 1989 to December 2005. Average inefficiency measures are derived for dominant banks for each quarter over the sample period. The bank performance measures utilized in the empirical analysis are return on assets and the net interest margin.

Return on assets is computed as the ratio of net income to average total assets while net interest margin is the interest revenue less interest expenses, as a proportion of total assets and is used as a proxy for the pricing ability of banks. The HHI index computed for the banking sector is used as a measure of concentration. A dummy variable is included to capture the financial crisis that occurred during the second half of the 1990s. A dynamic VAR framework is utilized in analysing the nature of the concentration – profitability relationship by incorporating inefficiency estimates, performance and concentration measures and the dummy variable as endogenous variables.[14]

[12] See Coelli (1996) for a complete discussion of FRONTIER.
[13] These estimates (except for the intercept) are unbiased.
[14] Inefficiency estimates included in the VAR model are based on the cost function which best fits the data.

5.0 Estimation Results

5.1 Technical Inefficiency Estimates

5.1.1 Translog Cost Function Estimates

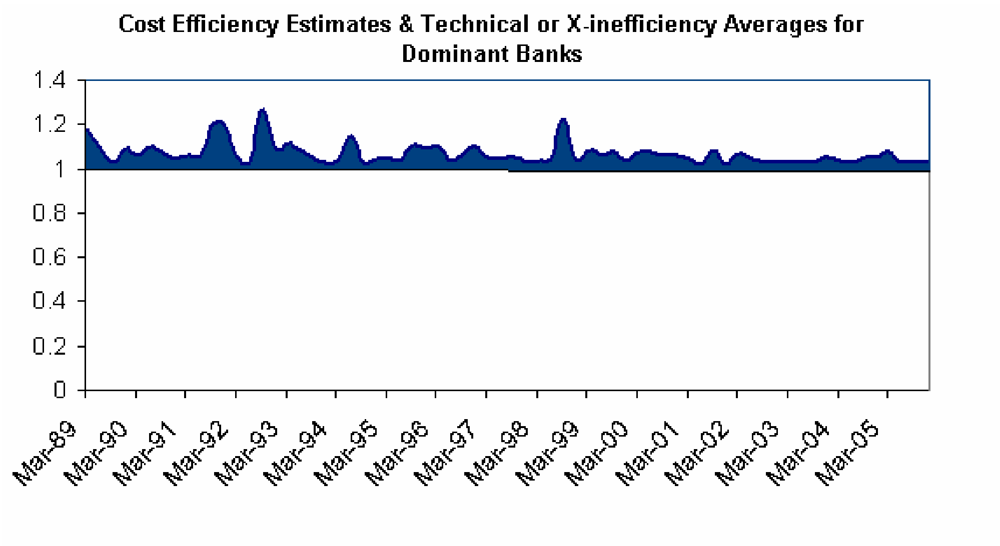
The maximum likelihood estimates of the translog cost function defined by equation (9) are presented in Table 2. The value of the γ parameter, which captures the variability related to the technical inefficiency component, is significant. This indicates that the translog model is a significant improvement over the standard OLS function. Additionally, output variables, y1 and y2, and the price variable p3* along with various interaction variables are positive and significant at the 10.0 per cent level (see Table 2). However, asset size and ROA were found to be statistically insignificant indicating that increases in these variables were not influential in determining technical inefficiency.

Table 2. Model parameters of the stochastic Translog cost function

Variable	Coefficient	t-ratio
Dependent variable: ln (cost)		
constant	-48.2*	-5.30
ln(Y1)	7.6*	6.50
ln(Y2)	-2.1*	-3.90
ln(P2*)	-0.10	-0.10
ln(P3*)	-1.4*	-1.90
ln(Y1)ln(Y1)	-0.30	-3.70
ln(Y1)ln(Y2)	-0.03	-0.35
ln(Y2)ln(Y2)	0.1*	5.10
ln(P3*)ln(P3*)	0.5*	4.80
ln(P3*)ln(P2*)	0.3*	2.40
ln(Y1)ln(P3*)	0.04	0.30
ln(Y1)ln(P2*)	-0.2*	-3.00
ln(P3*)ln(P3*)	0.10	1.30
ln(Y2)ln(P3*)	0.2*	4.40
ln(Y2)ln(P2*)	-0.03	-0.70
Gamma	0.98*	5.70
constant (delta0)	7.90	0.86
asset size	-0.38	-0.85
ROA	-38.1	-0.69

"*" Significance at 10% level

Figure 7



Based on the results from the estimated translog cost frontier, technical inefficiency for the dominant banks averaged 6.8 per cent over the sample period. This indicates that on average, dominant banks were incurring 6.8 per cent higher costs than necessary. Additionally, Figure 7 shows that for most of the period, these banks operated close to their efficient cost frontier. Nonetheless, the results indicate that there was a marked increase in technical inefficiency during the pre-liberalization period due to absence of strong competition in the sector. However, this performance improved substantially in the post-liberalization period. Not surprisingly, technical inefficiency also increased sharply to 23.0 per cent during the crisis period before moderating to fluctuate in a band of 3.0 to 7.0 per cent over the rest of the sample period.

5.1.2 Cobb-Douglas Cost Function Estimates

Table 3. Model parameters of the stochastic Cobb-Douglas cost function		
Variable	Coefficient	t-ratio
Dependent variable: ln (cost)		
constant	2.1*	14.25
ln(Y1)	0.43*	40.26
ln(Y2)	0.56*	57.46
ln(P1*)	0.61*	26.71
ln(P2*)	0.02*	18.33
Dependent Variable: Ineff		
constant	2.92*	8.04
asset size	-0.11*	-7.37
ROA	-8.52*	-3.77
Gamma	0.99*	149.36

"*" Significance at 5% level

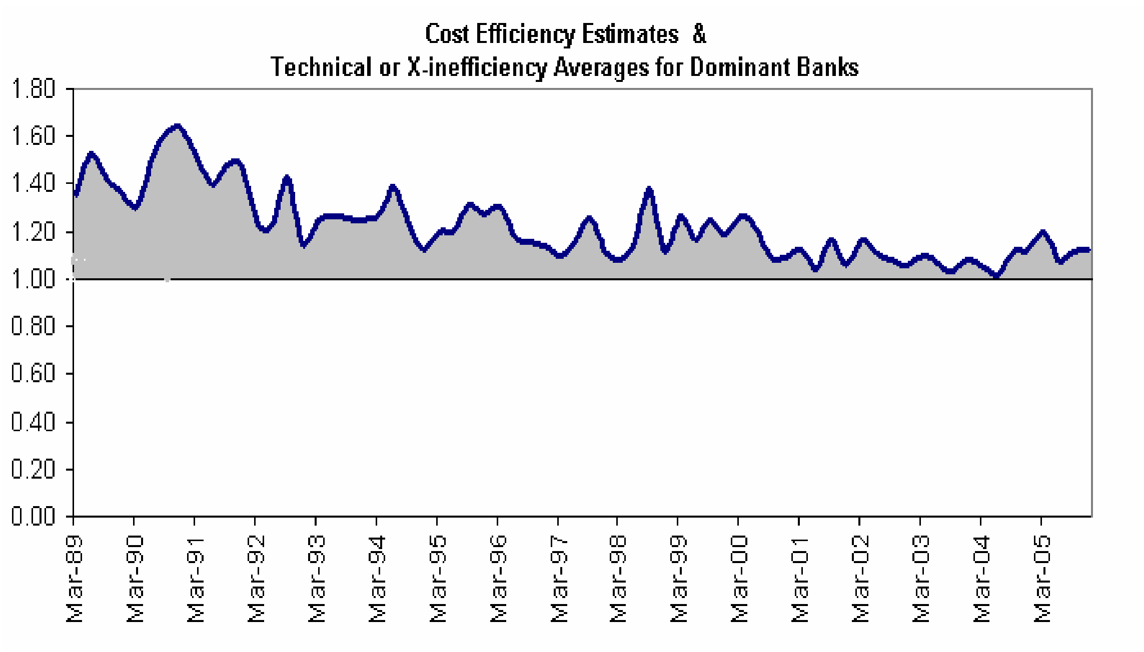
The results in Table 3 are based on the Cobb-Douglas cost frontier and indicate that all coefficients are significant at the 5.0 per cent level. In particular, gamma is statistically significant indicating that the proportion of the one-sided error component in the total variance of the error terms in the model is approximately 99.0 per cent. As such, technical inefficiency is the main source of random error in the model. The coefficients on asset size and ROA are negative and statistically significant indicating that increased asset size and profitability contribute to declines in technical inefficiency.

Figure 8 shows that the pattern of the technical inefficiency estimates are similar to that observed based on the translog function. Nonetheless, technical inefficiency estimates based on the translog and Cobb-Douglas functions deviated sharply prior to the crisis period but were more closely related subsequent to this period (see Figure 9 & Table 4). Estimates for both cost functions are compared in order to ascertain which model is a more appropriate fit for the data. The likelihood ratio test statistic was compared to the Chi-square critical value at the appropriate degrees of freedom.[15] The null hypothesis of the more restrictive Cobb-Douglas cost function was rejected at the 5.0 per cent level. As

[15] The test statistic was computed based on the likelihood function values for the Cobb-Douglas and translog cost functions. Since the test statistic follows a mixed Chi square distribution, critical values were based on Kodde Palm (1986).

such, inefficiency estimates from the translog cost function were used as inputs in the VAR framework.

Figure 8



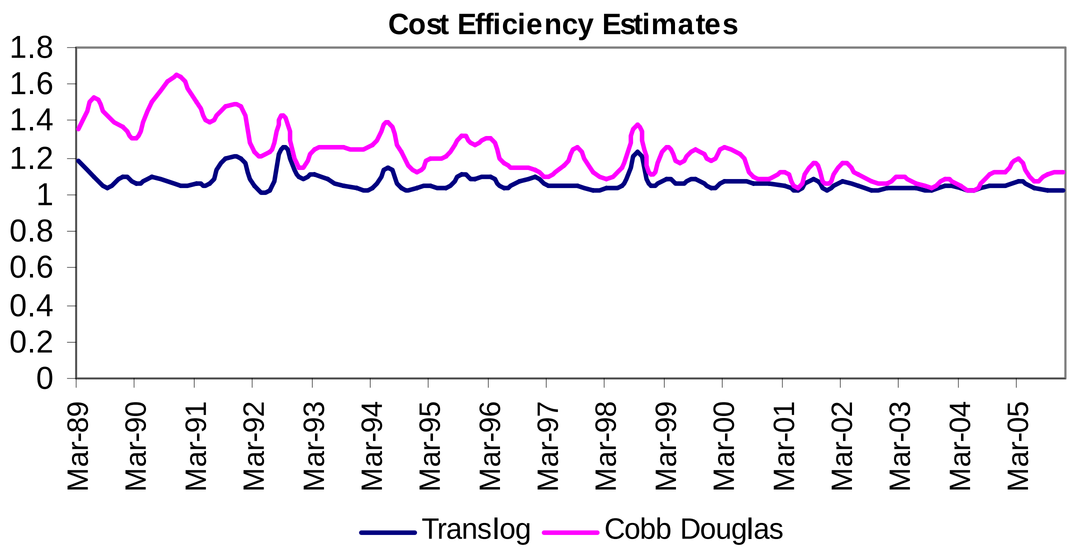


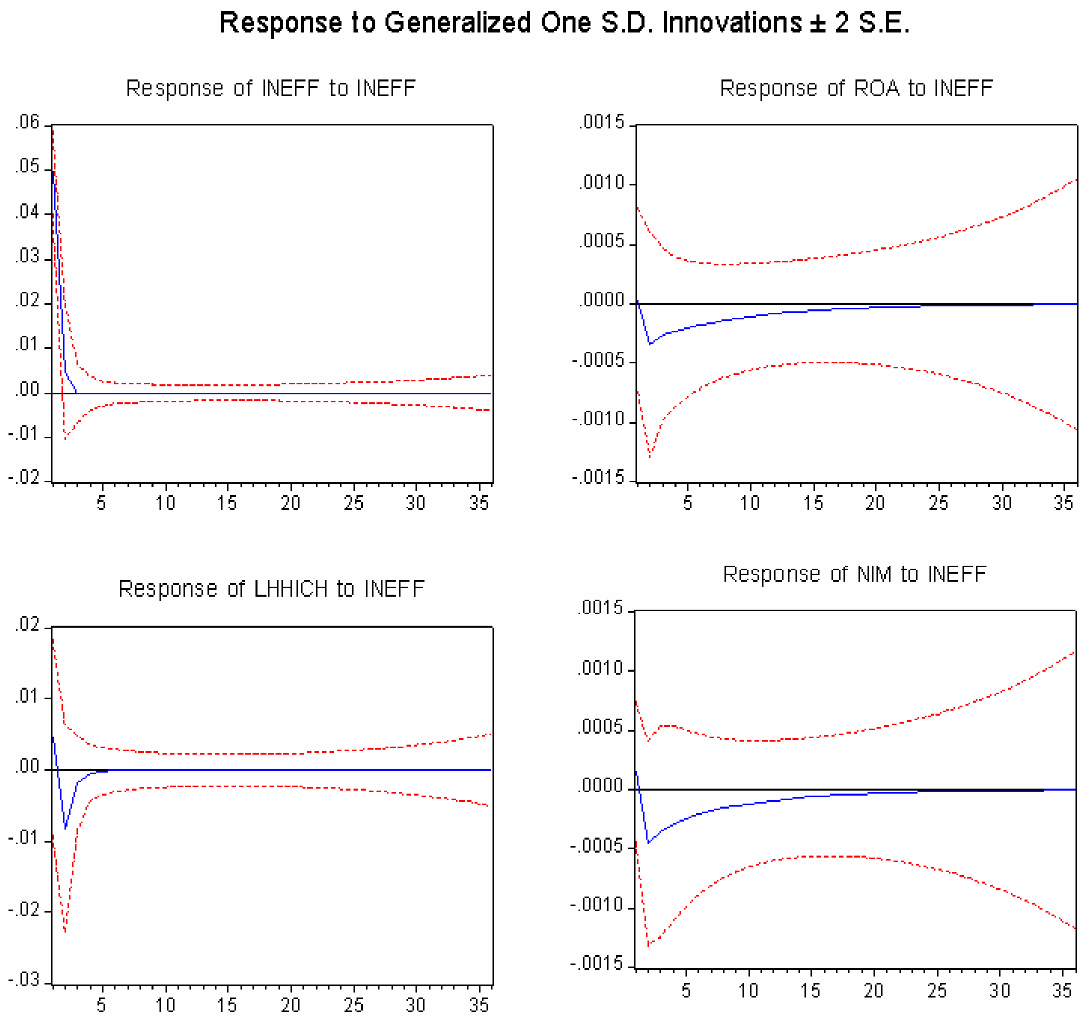
Table 4
Average X-inefficiency Estimates over different Sub-periods

Sub-periods	**Average X-ineff Estimates** *(per cent)*	
	Translog	**Cobb-Douglas**
Pre-Liberalization 1989 - 1991	10.0	46.7
Post Liberalization 1992 - 1995	8.0	25.4
Crisis period 1996 - 1999	7.0	18.7
Post Crisis 2000 - 2005	5.0	10.6
Entire Sample 1989 - 2005	6.7	22.3

5.2 Impulse Response Analysis

Figure 10 plots the impulse responses of ROA, HHI and NIM with respect to a one standard deviation increase in technical inefficiency over a horizon of thirty-six months. The VAR coefficient and standard errors from the model are computed by the Monte Carlo method with 1000 repetitions (of 2 standard deviations).

Figure 10



Generalized impulse response analysis is utilized, as it is invariant to the ordering of the variables in the VAR, resulting in a unique solution. A lag order of one was selected based on the Schwarz information criterion and the Hannan-Quinn information criterion.[16]

The impulse response suggests that shocks in inefficiency influences declines in overall profitability within the first three months, based on the ROA. Thus, profitability is inversely related to increases in inefficiency.

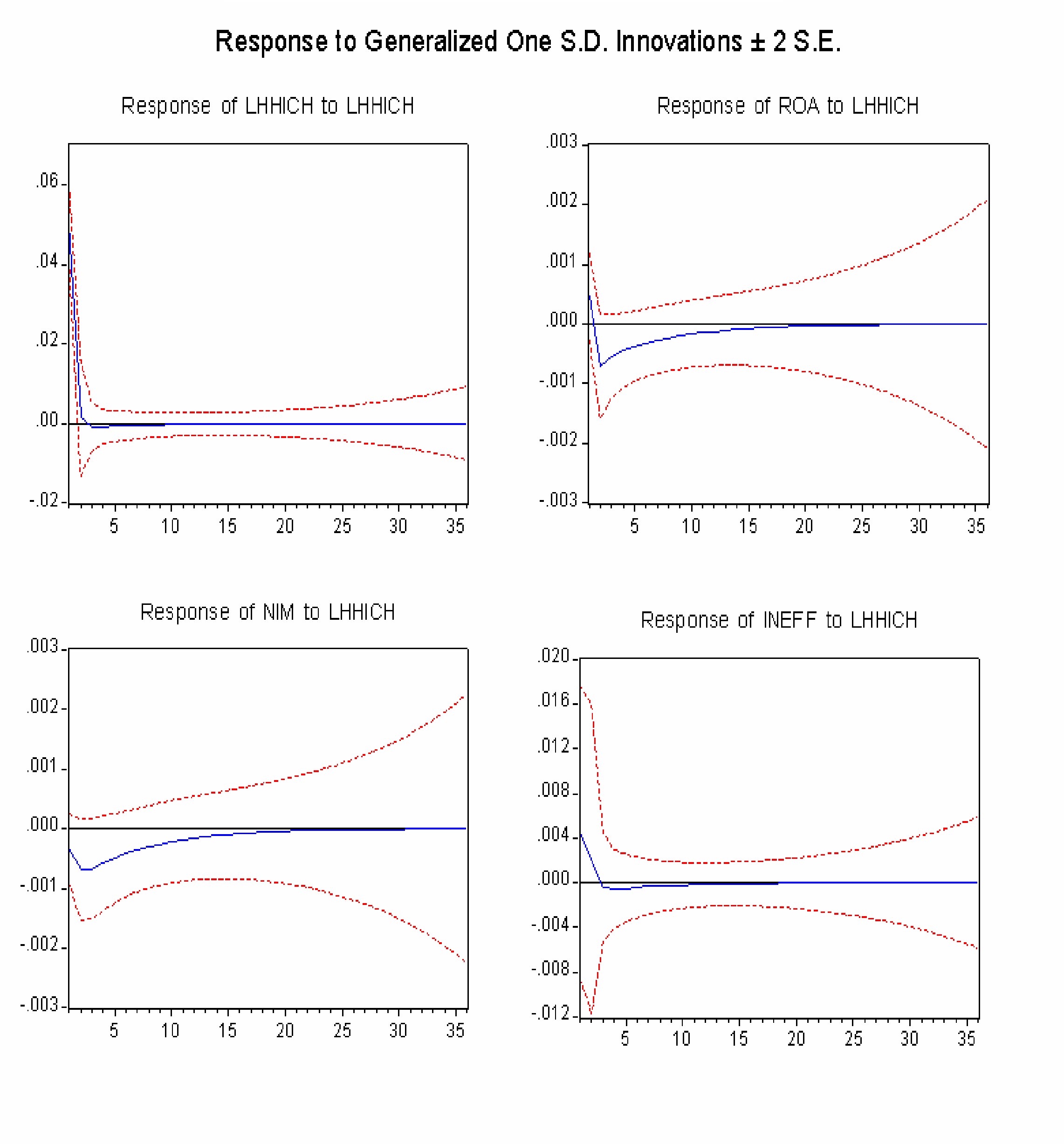
[16] See Table 5 in Appendix

This finding supports the EMH, which indicates that increases in efficiency are associated with increases in profitability. It is also observed that increases in inefficiency contribute to declines in concentration, suggesting that efficient firms are likely to gain larger market shares.

However, increases in inefficiency result in a decline in NIM, implying that lower inefficiency is associated with increases in NIM. This implies that declines in inefficiency are not translated into lower net interest margins being applied by the dominant banks. A possible explanation for this finding is that dominant banks have limited incentive to translate productivity improvements into lower interest margins because of the weak competition in the sector. As such, the relatively high interest margins in the domestic banking sector are indicative of the absence of strong competition rather than unfavourable pricing due to the presence of a large degree of inefficiency in the operations of dominant market players.

Figure 11 shows the response of technical inefficiency (ineff), ROA and NIM to a 1.0 unit shock in concentration. The findings do not support the SCP hypothesis. The results indicate that increases in concentration are associated with strong declines in both the profitability measures within the first three months. The results also show that increased concentration contributes to lower inefficiency.

Figure 11


Response to Generalized One S.D. Innovations ± 2 S.E.
Response of LHHICH to LHHICH
Response of ROA to LHHICH
Response of NIM to LHHICH
Response of INEFF to LHHICH
.06
.04
.02
.00
-.02
.003
.002
.001
.000
-.001
-.002
-.003
.020
.016
.012
.008
.004
.000
-.004
-.008
-.012
5
10
15
20
25
30
35

7.0 Conclusion and Policy Recommendations

The results suggest that dominant banks are operating with a high degree of efficiency. Based on findings from the translog cost function, dominant banks would only need to reduce costs by 7.0 per cent to achieve their optimal level of efficiency. This estimate compares favourably to findings in the US banking industry.[17]

The pattern of technical inefficiency estimates for the dominant banks indicates that there was increased inefficiency prior to the liberalization period as well as during the crisis period. Both cost frontier approaches indicate that technical inefficiency has remained relatively stable subsequent to the crisis period, fluctuating in narrow band of 3.0 per cent to 5.0 per cent.

Results from the VAR framework reject the SCP hypothesis, indicating that profitability of the dominant banks in the industry is not driven by monopolistic conduct. While the profitability of the dominant banks is driven by the efficiency in their operations, this performance is not reflected in the pricing policies of these banks. This suggests that despite gains in productivity, dominant banks are unlikely to administer lower net interest margins in the absence of greater competition in the banking system.

There is further need for regulatory authorities to engineer continued incremental reductions in policy rates in an effort to increase competition in the banking sector and avoid destabilizing the system. The lower interest rate environment could stimulate increased competition in the sector, as commercial banks reduce their reliance on earnings from Government debt issues and realign their asset portfolios towards core business activities. Additionally, continued improvement in the fiscal position and Government's debt sustainability should further reduce the banking sector's reliance on earnings from debt instruments.

[17] See Kwan (2001).

Reductions in domestic interest rates should be accompanied by moral suasion by regulatory authorities. Policymakers can promote a competitive environment by encouraging dominant banks to increase performance by expanding business volumes by narrowing their interest margins. The increased competitiveness of the dominant market players could influence greater competition in the supply of loanable funds in the sector.

There is some debate as to the competitive structure that optimizes efficiency and financial stability. Market power can contribute to stability by mitigating risk-taking behaviour and providing incentives to screen and monitor loans, which can improve the quality of banks' portfolios. In this context, rather than pursuing efforts to minimize market power, regulatory authorities should seek to facilitate an environment that promotes competitive behaviour. Regulatory authorities can stimulate competition by promoting the establishment of independent credit rating agencies, as the lack of accurate, reliable information about borrowers' ability to pay increases credit risk and hence lending rates.

It is also important to ensure that the regulatory framework is accommodative of product innovations, as strong restrictions on new products and services can decrease competitiveness in the banking industry. Claessens and Laeven (2003), estimated competitiveness indicators for a large cross-section of countries and found evidence that fewer activity restrictions in the banking sector can increase competitiveness in the system. Additionally, regulatory authorities must carefully evaluate the costs and benefits of mergers and acquisition in order to safeguard consumer welfare and promote competition in the sector.

8.0 References

Aigner, D., lovell, C.A.K., and Schmidt, P. (1977), "Formulation and Estimation of Stochastic Frontier Production Function Models", Journal of Econometrics, 6, pp.21-37.

Bain, J.S. (1951), "The Relation of Profit Rate to Industry Concentration: American Manufacturing", Quarterly Journal of Economics, 65, pp. 293 – 324.

Berger, A.N. (1995), "The Profit-Relationship in Banking-Tests of Market-Power and Efficient-Market Hypotheses", Journal of Money, Credit and Banking, 27, pp. 405 – 431.

Berger, A.N., and Hannan, T.H. (1989), "The Price-Concentration Relationship in Banking", Review of Economics and Statistics, 71, pp. 291 – 299.

Berger, A.N., Hunter, W.C., and Timme, S.G. (2003), "The Efficiency of Financial Institutions; A Review and Preview of Research Past, Present, and Future", Journal of Banking and Finance, 17, pp. 221 – 249.

Cebenoyan, A.S., Cooperman E.S., Register C.A., and Hudgins S.C., The Relative Efficiency of Stock versus Mutual S&Ls: A Stochastic Cost Frontier Approach, Journal of Financial Services Research.

Chirwa, Ephraim, W.T. (2003), "Determinants of Commercial Banks' Profitability in Malawi: A Cointegration Approach", Applied Financial Economics, 13, pp. 565 – 571.

Chirwa, Ephraim, W.T. (2001), "Market Structure, Liberalization and Performance in the Malawian Banking Industry", AERC Research Paper 108, Nairobi: African Economic Research Consortium.

Civelek, M.M., and Al-Alami, M.W. (1991), "An Empirical investigation of the Concentration-Profitability Relationship in the Jordanian Banking System", Savings and Development, 15, pp. 247 – 259.

Claessens, Stijn, and Laeven, L. (2003), "What Drives Bank Competition? Some International Evidence", World Bank Policy Research Paper No. 3113.

Coelli, T.J.(1996), "A Guide to Frontier Version 4.1: A Computer Program for Stochastic Frontier Production and Cost Function Estimation", Centre for Productivity and Efficiency Analysis, University of New England, Armidale.

Coelli, T.J., Singh, S. and Fleming, E. (2000), "Measurement of Technical and Allocative Efficiency in Indian Dairy Processing Plants: An Input Distance Function", CEPA Working papers, No. 3/2000.

Duncan, D. (2002), "Testing for Competition in the Jamaican Banking Sector: Evidence from Bank Level Data", Available via the Internet: http://www.boj.org.jm

Frame, W.S. and Coelli, T.J. (2001), "U.S. Financial Services Consolidation: The Case of Corporate Credit unions", Review of Industrial Organization, 18, pp. 229 –242.

Katib, M. Nasser (2004), "Market Structure and Performance in the Malaysian Banking Industry: A Robust Estimation", Available via the Internet: http://papers.ssrn.

Kodde, D.A., and Palm, F.C. (1986), "Wald Criteria for Jointly Testing Equality and Inequality Restriction", Econometrica, 54, pp. 1243 – 1248.

Kwan, Simon, H. (2001), "The X-Efficiency of Commercial Banks in Hong Kong", Federal Reserve Bank Working Paper.

Limam, Imed, "Measuring Technical Efficiency of Kuwait Banks", Available via the Internet: http://econpapers.repec.org

Molyneux, P. and Forbes, W. (1995), "Market Structure and Performance in European Banking", Applied Economics, 27, pp. 155 – 159.

Rai,A. and Goldberg, L.G.(1996), "The Structure-Performance Relationship for European Banking", Journal of Banking and Finance, 20, pp. 745 – 771.

Rai, A. (1996), "Cost Efficiency of International Insurance Firms", Journal of Financial Services Research, 10, pp. 213 – 233.

Robinson, J. (2002), "Commercial bank Interest Rate Spreads in Jamaica: Measurement, Trends and Prospects" (unpublished; Kingston: Bank of Jamaica)

Smirlock, M. (1985), "Evidence on the (Non) Relationship between Concentration and Profitability in Banking", Journal of Money, Credit and Banking, 17, pp. 69 – 83.

Worthington, A. (1998), "The Determinants of Non-bank Financial Institution Efficiency: A Stochastic Cost Frontier Approach", Journal of Econometrics, 8, pp. 279 – 289.

APPENDIX

Figure 12

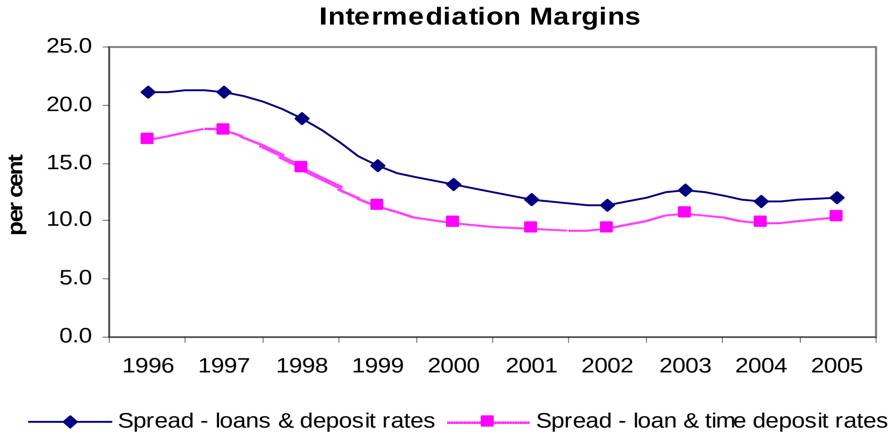


Table 5 VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	692.6106	NA	1.11E-16	-22.54461	-22.37159	-22.4768
1	797.674	189.4586	8.09e-18*	-25.16964*	-24.13150*	-24.76278*
2	811.1723	22.1284	1.20E-17	-24.79254	-22.88929	-24.04663
3	821.3654	15.03893	2.03E-17	-24.30706	-21.5387	-23.22212
4	856.0405	45.47558	1.61E-17	-24.62428	-20.99081	-23.20029
5	868.7244	14.5553	2.79E-17	-24.22047	-19.72189	-22.45744
6	920.2128	50.64437*	1.47E-17	-25.08895	-19.72525	-22.98686

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion