Capital Requirements and Commercial Bank Behaviour: The Jamaican Experience

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Abstract

This paper uses a structural, dynamic model of the banking firm to examine how Jamaican banks respond to both leverage and risk-based capital requirements. Dynamic programming techniques were applied and the model estimated within a Seemingly Unrelated Regression Equation (SUR) framework using a panel data set on Jamaican banks. The results show that capital requirements are significant considerations in the profit- maximizing plan of banks. However, the imposition of the risk-based requirements in 1999 seemed to have changed the incentive structure of banks, causing a shift away from assets containing default risk and into default-free assets. The positive sign on the estimated marginal risk-based requirement cost suggests that banks keep a relatively high buffer on their risk-based capital ratios in order to avoid potential regulatory costs. However, the negative sign on the estimated marginal leverage requirement cost suggests that banks actually reap a net gain from declining close to the leverage requirement.

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1.0 Introduction

The Jamaican banking sector has undergone many changes over the past decade. Spearheaded by the recommendations of the Basle Committee on Banking Supervision, [2] there has been a thrust towards a more risk-based and consolidated regulatory framework. The recommendations of the Basle Committee have provided most of the impetus for recent regulatory improvements in Jamaica. The 1988 Basle Accord was adopted in Jamaica in 1999 as a "standard of best practice," to complement the existing leverage requirement, for banks to maintain prudent capital positions. The Accord defined "risk buckets" that group bank assets with presumably similar risk as well as a credit risk-based weighting mechanism to arrive at the banks' risk-adjusted asset value. In 1996, the Basle Committee proposed an amendment to the 1988 Accord to cover risks that arise from market factors.[3] The general objectives behind the implementation of these risk-based requirements were to:

(1) make regulatory capital more sensitive to differences in risk profiles among banking organisations;
(2) take off-balance sheet exposures explicitly into account in assessing capital adequacy; and
(3) lower the disincentives to holding liquid, low risk assets.[4]

Recently, important questions have been raised concerning the success of the minimum capital requirements. Has the minimum capital requirements and, in particular, the risk-based capital requirement, produced undesirable side effects? Did the risk-based capital requirement lead to increased capital or a reduction in risk-weighted assets? Was a "credit crunch" created by the adoption of the risk-based requirement? This paper answers these questions through an empirical examination of the dynamics of Jamaican bank behaviour within the context of the risk-based and leverage capital requirements. It uses Furfine's (2000) model in structuring the banks' problem within a dynamic optimisation framework. Employing the assumption of profit maximization, salient variables within the banking sector are incorporated within the model with a view towards a realistic assessment of the response of banks to capital requirements. Special interest lies in how adherence to the requirements affects the bank's revenue/cost structure in order to analyse the incentives that exist for banks to make portfolio adjustments.

A major goal of banks is to optimally balance risk with returns in the conduct of financial intermediation. Banks are exposed to various types of risk. Two common types are credit risk and market risk. The default or credit risk of the bank arises from the fact that some debtors may not repay the outstanding balances owed to the bank. Market risk concerns the exposure of the bank's portfolio to

[2] The signatories to the agreement were Belgium, Canada, France, Germany, Italy, Japan, Luxembourg, Sweden, the Netherlands, the United Kingdom, the United States and Switzerland.
[3] See Basle Committee on Banking Supervision (1996).
[4] See Basle Committee on Banking Supervision (1999).

unanticipated movements in market prices including interest rates and foreign exchange rates. Although not an exhaustive list, credit and market risks need to be prudently managed by banks. Failure to manage these risks might lead to instability in the financial system, including the risk of bank failure and contagion.

The presence of risk therefore creates the need for some measure of the value for a bank, such as its net worth, against which debt-holders can claim if the bank becomes illiquid. The bank's net worth, or economic capital, is closely associated with the book value of capital recorded in the bank's balance sheet.[5] Minimum capital requirements are designed to ensure that the bank preserves its net worth. The leverage ratio requirement sets a lower bound for the ratio of a bank capital to total assets.

A low net worth limits the ability of the bank to honour its liabilities to depositors should the bank become insolvent. Additionally, low net worth of banks make it difficult for these banks to access funding since the banks' creditors will not want to take on the risk of unsecured lending.[6] Finally, there are moral hazard implications since it is argued that a low net worth means that the owners of the bank have a lower proportion of their wealth at stake should the bank fail and will therefore have an incentive to undertake more risky ventures. These propositions suggest that there is a strong a relationship between bank's capital or net worth, its risk and leverage requirements and its portfolio choice.

Figure 1 and 2 display the trends in Jamaican bank portfolio behaviour over the sample period 1989 to 2003. As shown in Figure 1, assets considered to be default-free accounted for a relatively smaller proportion of commercial bank portfolios until the late 1990s. Subsequently, the movement by banks into default free securities and away from risky assets became more pronounced, with default free securities exceeding risky assets by J$9.8 billion in September 2000. This represented an all-time high within the sample period. However, subsequent reductions in interest rates resulted in an increased demand for loans and hence resurgence in loan supply, dampening the growth in Government securities in banks' portfolios. Nevertheless, commercial banks portfolios continued to be heavily concentrated in Government securities relative to private loans.

As seen in Figure 2, the capital ratios of the banks reflected these portfolio shifts, with the average industry risk-based ratio exceeding the average leverage ratio of the industry by over 20 per cent during 2001. These changes all occurred against the background of the introduction of the risk- based standard in Jamaica in 1999. It is plausible therefore, that the implementation of the risk-based standard did influence, in some way, the portfolio choice of Jamaican banks during the sample period. The paper utilizes a structured approach in exploring these relationships.

[5] Differences in the two figures result whenever market valuations on the net assets differ from the value in the bank's books.

[6] See Van Den Heuvel (2002)

1.1 Risk- Based Capital Adequacy Standards

This paper analyses the behaviour of banking institutions within the context of the Basle Accord of 1988 and the subsequent amendment in 1996. This agreement on standards of capital adequacy arose following the failure of savings and thrift institutions in the USA and indeed the proliferation of banking crises in other nations across the world during the 1980s. The thrust of the Agreement was to integrate the standards of capital adequacy across countries and to supplement the existing leverage requirement,[7] by accounting for the risks associated with banks portfolios. The risk-based ratio requirements were not applicable in Jamaica before 1999 and since then, though not explicitly legislated,[8] have been enforced on the grounds of "standards of best practice" by the supervisory institutions.

More specifically, the Jamaican credit risk-based standards attach risk weights to broad categories of on and off- balance sheet activities. Similar to the Basle Agreement, assets are classified into four categories. The lowest category carries a zero weight and contains those assets with the least risk such as cash reserves and government securities. The next lowest category has a risk weight of 20 per cent and includes inter-bank deposits, claims on banks or licensees and securities issued by government agencies. The third category attracts a risk weight of 50 per cent and includes residential mortgages. The last risk category has a maximum weight of 100 per cent and includes remaining securities such as commercial paper, loans[9] and fixed assets[10]. Off- balance sheet activities are also 100 per cent risk weighted. The weights for the items on the balance sheet of Jamaican banks are presented in Table 2 in the Appendix.

Under the 1996 Amendment, the Basle market risk-based standards incorporated risks pertaining to interest rate-related instruments, equities, foreign exchange positions and commodities. Presently, the "best practice" requirements of the BOJ include only those risks that pertain to movements in the foreign exchange rate. The current recommendation describes two processes that are needed to calculate the capital requirement for foreign exchange risk as follows: (a) firstly, the measurement of the exposure in a single currency position; (b) secondly, the measurement of the risks inherent in the bank's mix of long and short positions in different currencies. A bank's net open position is computed as the aggregate of its net spot and forward positions, any guarantees that are certain to be called and are likely to be irrecoverable as well as any other item representing a profit or loss in foreign currencies.

According to BOJ-monitored capital standards, a bank is expected to meet two minimum requirements: the leverage requirement, which is the ratio between its capital base and total assets, less provisions for losses at *no less than six per cent*; and the risk-based requirement, which is the ratio

[7] The leverage ratio is simply a ratio of a banks capital to the total amount of its assets less its provisions for loan losses.
[8] A draft document to be included in the Banking Act has been prepared but has not yet been passed as law. See the Banking (Capital Adequacy) Regulations (*Draft*, 2003).
[9] This includes both commercial and real estate construction loans
[10] such as bank building, computers etc.,

between its capital base and the aggregate of its on-balance sheet assets, off-balance sheet items, and balances related to managed funds and foreign exchange risk exposure at *no less than ten per cent*. The formula for determining risk-based capital adequacy in the Jamaican banking sector is illustrated as:

$$\frac{Capital\quad Base}{Credit\quad Risk\quad -\ weighted\quad Assets\quad +\ (Market\quad Risk\quad Capital\quad Ch\ \arg\ e \times 12\ .5)} \geq 10\ \%$$

The risk- based capital standards recommended by the BOJ are not without their limitations. One major flaw is the fact that the risk-based standards only account for the credit and foreign exchange risks. This excludes other risks such as interest rate, liquidity and operation risks, which can potentially incur significant capital losses. For example, a bank may choose to simply substitute away from assets with high credit risk towards assets that possess considerable interest rate risk. Since the risk- based measure does not account for interest rate risk this move will remain unaccounted for by capital. Such examples lead to the hypothesis that the current risk-based capital requirements may affect bank's risk behaviour adversely.[11] There are also problems with deriving the optimal risk weights to be applied.[12] Another potential problem with risk-based capital standards is that they do not limit the amount of risk in a bank's asset portfolio. That is, they simply estimate the amount of capital that must be held concomitant with the credit risk present in the portfolio, whatever the level of risk.

Based on these shortcomings the Basle Committee has sought to refine the risk-based requirements with a view to making them even more "risk sensitive." These revisions are being amended for implementation in 2005. Changes that have been proposed include making the risk weights dependent on the ratings of borrowers. These ratings could be sourced externally (for example, from some rating agency) or evaluated internally based on the banks own model for risk assessment. With these changes, elements of other types of risk might also be incorporated into the risk-based capital measure.

The rest of the paper is organized as follows. Section 2 will survey the pertinent literature to motivate an appreciation for a few of the issues involved in the analysis, Section 3 will present the model and its assumptions. Section 4 and 5 discuss the data and method of estimation, respectively. The empirical results are presented in section 6. Section 7 states the conclusions and implications for policy.

2.0 Literature Review

There has not been much research on the response in the portfolios of Jamaican banks to the imposition of capital requirements. However, prior work has been done on general portfolio bank behaviour. Bourne (1977) investigated this topic over the sample period 1962 to 1971, which represented a period when all Jamaican commercial banks were subsidiaries of overseas banks. He found insignificant

[11] See for example Genotte and Pyle (1991) and Koehn and Santomero (1980).
[12] Avery and Berger (1991) also Kim and Santomero (1988) argue that these optimal weights represent an upper bound on the probability of insolvency.

changes in bank portfolios in response to interest rate changes. Problems controlling for correlation as well as the theoretical assumptions underlying the specification of the model limited the inferences that could be drawn about the risk behaviour of banks. Furthermore, the current applicability of his paper is questionable, since the financial markets and regulatory institutions as well as the economic climate have since undergone significant changes.

More recently, however, research by Hines and McDonald (2000) corroborated Bourne's (1977) findings of limited bank portfolio response to interest rate changes over the short term. The study also revealed the importance of the evolution of deposits to the long-run supply function of banks. Using a VAR extension to a SUR model, it was discovered that there was heterogeneity among banks with respect to their portfolio responses to changes in the financial environment. One drawback is that this paper lacks an adequate structured approach to analyse general bank behaviour within the context of profit optimisation. Though numerous other contributions have been made concerning the banking sector, the focus of the local literature has been on the history,[13] efficiency of banks[14] as well as financial stability and bank failures.[15]

More extensive research has been conducted in the international literature on the role that the new capital requirements played in the popular U.S "credit crunch" period beginning in 1989 and continuing into 1990s. In work by Berger and Udell (1994), Bernanke and Lown (1991) and Hall (1993) bank loan growth was regressed on measures of bank capital along with other control variables for loan demand. The conclusions by these various authors were mixed and are prone to criticism since the models used lacked a structural approach to modelling bank's behaviour. Moreover, the magnitude and significance of the coefficients on the capital terms were incorrectly used to infer statistical causality between the capital requirements and the "credit crunch" [16] witnessed in the U.S. shortly after the passing of the Basel Accord and into the nineties.

A structured analysis examining the role of capital requirements is offered by Shrieves and Dahl (1995) and Jacques and Nigro (1997). Both papers estimated dynamic models for bank behaviour. These papers concluded that the level of risk-based capital requirements affected the loan supply of commercial banks. However, the theoretical justification for the equations employed was often lacking even though problems of inferring causality encountered by previous studies were overcome. Hancock, Laing and Wilcox (1995) adopted a similar approach and concluded that banks adjust their capital ratios much faster than they adjust their loan portfolios. Though helpful, their study cannot be a basis for any rigorous

[13] See Lue Lim (1991).
[14] See N. Panton (1998).
[15] See Stennett, Batchelor and Foga (1998), and Langrin (2001).
[16] This term is defined by Berger and Udell (1994) as the significant decline in the supply of credit available to commercial borrowers.

examination of the effects of capital requirements on bank behaviour unless one assumes equivalence between capital requirements and bank capital.

The theoretical literature has at its focal point the relationship between capital requirements and risk taking by the regulated banks. Previous research by Flannery (1989), Khoen and Santomero (1980) and Gennotte and Pyle (1991) all examine these issues. However, a structural approach to assessing the nature of the impact of capital requirements was not achieved and the results obtained were contradictory. Not all papers corroborated the intuition that any regulatory measure that increases the cost of risky investment will cause banks to substitute away from these prospects into safer instruments.

3.0 The Model[17]

The structural framework for modelling the bank's behaviour takes the form of a dynamic profit-maximization problem subject to the constraint of the evolution of its capital stock. Before setting up the problem, however, consider the simple bank balance sheet equation:

$$L_t + S_t = D_t + K_t \tag{1}$$

Where L_t represents the bank's loan stock at time t, S_t represents the default-free securities held by the bank at t, D_t represents the stock of deposits in period t and K_t denotes the capital stock of the bank at time t. The characteristic feature of the loan stock is the presence of credit risk. Contrastingly, the other assets held by the bank are assumed to be free of default risk.

The banks' capital could be viewed as a constraint on its profit since higher levels of capital cause a reduction in expected return. As such, it is logical to assume that the capital evolves according to the following differential equation:

$$K_t = K_{t-1} + r_t^L L_t + r_t^S S_t - r_t^D D_t + Q_t + \varepsilon_t \tag{2}$$

Where r_t^L denotes the interest rate on loans, r_t^S is the rate of interest earnings on default free securities, r_t^D represents the interest paid on the deposits of the bank, Q_t is used to represent the amount of net equity issued by the bank, the ε_t term captures the stochastic nature of the evolution of capital from uncertainty across markets. The per dollar cost of issuing capital is modelled explicitly as $\lambda(q_t)$, where:

$$q_t = \frac{Q_t}{L_t + S_t}^{18}. \tag{3}$$

The model captures two types of capital requirements. The leverage ratio (k_t^L), which serves as a criterion for bank balance sheet assessment, can now be expressed in terms of the defined parameters as:

[17] The model is structured along the lines of Furfine (2000)
[18] This specification is merely for algebraic convenience.

$$k_t^L = \frac{K_t}{L_t + S_t}, \qquad (3')$$

and the chosen specification for the risk-based capital ratio (k_t^R) is represented by:

$$k_t^R = \frac{K_t}{a_t L_t}, \qquad (3'')$$

where the a_t term are risk-weights of which the bank has perfect knowledge at each point in time.

The bank is subject to regulatory requirements that specify the minimum levels of each ratio that must be attained. These minima are c_t and d_t for the leverage and risk-based capital requirements, respectively, so that the regulators desire the following conditions: $k_t^L > c_t$ and $k_t^R > d_t$. Importantly, for the capital requirements to achieve their objectives it must be costly for the bank to approach either minimum requirement. These regulatory costs are assumed to be of a continuous nature and vary positively with the amount of risk-weighted assets or total assets owned by the bank. In practice, these costs are administered through the regulatory body and may also include additional costs via market discipline. The costs are specified as,

$$(a_t L_t)\, g(k_t^R - d_t), \qquad (4)$$

which reflect the costs incurred whenever the bank approaches (from above) the risk-based capital requirement, and

$$(L_t + S_t)\, h(k_t^L - c_t), \qquad (4')$$

which reflect the costs incurred whenever the bank approaches (from above) the leverage ratio requirement. The functions g and h measure the per dollar costs of approaching the respective capital requirements. Both functions are convex and decreasing, which represents the declining costs associated with increasing the buffer above the minimum capital requirements. The model also allows for the inclusion of those banks that might not meet requirements in specific periods.

There is evidence to suggest that banks face costs whenever co-movements in loan demand and supply are not perfectly synchronized. For example, a fall in the supply of loans relative to demand may result in deterioration in customer relations and hence the withdrawal of deposits. On the other hand, excess growth in loan supply may lead to imprudent risk-taking. The functional form, $L_t j(l_t - \rho_t)$ describes these adjustment costs at time t, where $l_t \equiv L_t / L_{t-1}$ is the gross growth rate of lending at time t, ρ_t is a measure of loan demand at time t and j is a convex adjustment cost function (with a minimum at ρ_t). This asymmetric functional form implies that any disparities between loan demand and supply is costly in the case of supply-driven differences.

3.1 The Bank's Maximization Problem

The bank's profit maximization problem is expressed as:[19]

$$\underset{\{L_t,S_t,Q_t\}|_{t=1}}{Max_{\infty}} \; E\sum_{t=1}^{\infty}\beta^t\left(r_t^L L_t - L_t j(l_t-\rho_t) + r_t^S S_t - r_t^D D_t - aL_t g(k_t^R - d_t) - (L_t+S_t)g(k_t^L - c_t) - Q_t\lambda(q_t)\right) \tag{5}$$

subject to the evolution of capital expressed in equation (2) and rewritten for algebraic convenience as:

$$K_t = \frac{1}{\left(1-r_t^D\right)}\left[K_{t-1} + (r_t^L - r_t^D)L_t + (r_t^S - r_t^D)S_t + Q_t + \varepsilon_t\right] \tag{2'}$$

Solving[20] this maximisation problem yields the following first-order conditions for optimality:

$$L_t: \quad \begin{aligned} &\left(\frac{r_t^L - r_t^D}{1-r_t^D}\right)\left(1 - g'(k_t^R - d_t) - h'(k_t^L - c_t)\right) - a\left[g(k_t^R - d_t) - g'(k_t^R - d_t)k_t^R\right] \\ &- \left[h(k_t^L - c_t) - k_t^L h'(k_l^t - c_t)\right] + q_t^2\lambda'(q_t) - \left[l_t j'(l_t - \rho_t) + j(l_t - \rho_t)\right] \\ &= -\beta E_t l_{t+1}^2 j'(l_{t+1} - \rho_{t+1}) \end{aligned} \tag{6}$$

$$S_t: \quad \left(\frac{r_t^S - r_t^D}{1-r_t^D}\right)\left(1 - g'(k_t^R - d_t) - h'(k_t^L - c_t)\right) - \left[h(k_t^L - c_t) - k_t^L h'(k_t^L - c_t)\right] + q_t^2\lambda'(q_t) = 0 \tag{7}$$

$$Q_t: \quad \left(\frac{1}{1-r_t^D}\right)\left(r_t^D - g'(k_t^R - d_t) - h'(k_t^L - c_t)\right) - q_t\lambda'(q_t) - \lambda(q) = 0 \tag{8}$$

Equation (6) ensures that the time t profit is maximized since the bank is equating the discounted future marginal adjustment costs to the time t marginal return. This condition takes into account the marginal equity issuing costs as well as the marginal costs of approaching both capital requirements. Equation (7) equates the marginal returns from the bank's investments in default-free securities to the marginal equity issuing and capital requirement costs. Finally, equation (8) provides the optimal equity issuing condition.

[19] The profit maximization assumption does not preclude the pursuit of other strategies by banks during any given period. Indeed, it is plausible that banks may choose to sacrifice maximum profits during some time period t to pursue other objectives. For example, a bank may choose to price a weaker bank out of the loan market in order to reap the benefits of less competition in the future. The model allows for this but retains the profit maximization motive as the long-run goal of banks since such behaviour is consistent with this motive in the long run.

[20] This paper views the bank's dilemma as an example of a deterministic infinite horizon dynamic programming optimization problem since banks do not have perfect knowledge of when they will exit the industry.

4. 0 Data

Commercial bank data were obtained from the Bank Supervision System database, which is maintained by Financial Institution Supervisory Department (FISD) of the Bank of Jamaica. The data used are quarterly, beginning in the first quarter of 1989 and ending in the first quarter of 2003. The risk-based capital ratio requirement was not enforced as a standard of best practice in Jamaica prior to 1999 so that there are no data entries for this variable prior to 1999. The sample consists of 11 commercial banks that have operated in Jamaica during the period of investigation.[21] Some of the banks may have merged with other entities during the sample period while others may have entered or exited the industry. Merged banks are treated as if they have exited the industry. Observations with leverage ratios below 6 per cent and risk-based ratios below 10 per cent were dropped from the data set. This was done to prevent the results from being biased by the behaviour of unhealthy banks.

A zero-one indicator variable was also included in the data set to control for the effects of the financial crisis of the 1990's and the subsequent intervention of Financial Sector Adjustment Company (FINSAC) to close down or recapitalize banks that were *defacto* insolvent. The reason for the inclusion of this crisis dummy is that these events would have altered significantly general profit-maximizing bank behaviour. This crisis dummy runs from 1995 to 2000 and is allowed to interact with all coefficient terms estimated in the system.

The commercial bank overall average weighted commercial bank loan rate was used for the loan rate variable (r_t^L) and the overall average weighted time deposit rate for commercial banks for the deposit rate (r_t^D). The risk-free rate (r_t^S) was proxied by the average yield on the 180-day Government of Jamaica Treasury bill. For quarters in which this instrument was not offered, the equivalent rate was computed using the instrument with the closest tenor.

5.0 Estimation

The following functional forms were used to capture the behavioural patterns of the bank's costs:

$$g(.) = \eta_o - \frac{\eta_1}{3}\left(k_t^R - (d + \hat{d})\right)^3$$

$$h(.) = v_0 - \frac{v_1}{3}\left(k_t^L - (c + \hat{c})\right)^3 \qquad (10)$$

[21] The banks included in the sample are National Commercial Bank (NCB), Union Bank of Jamaica (UBJ)-Royal Bank of Trinidad and Tobago (RBTT), Bank of Nova Scotia (BNS), Canadian Imperial Bank of Commerce (CIBC)-First Caribbean Bank, Eagle Commercial Bank (ECB), Citizens Bank Limited (CBL), Island Victoria Bank (IVB), Trafalgar Commercial Bank (TCB)-First Global Bank, Citibank (CBNA),Century National Bank (CNB), and Workers Savings and Loans (WSL).

$$j(l_t - \rho_t) = \frac{1}{2}\alpha(l_t - \rho_t)^2$$

$$\lambda(q_t) = \theta_0 + \frac{1}{2}\theta_1(q_t - \bar{q})^2$$

According to the econometric specification η_0, v_0 and θ_0 are contemporaneously fixed components of the risk-based, leverage and equity issuing costs, respectively. The cubic specification used to describe the risk-based and leverage costs ensures that the faster the bank's ratios decline towards the minimum capital requirements, and outside a given bound, the greater is the rate of increase in the costs applied by the regulators.[22] This specification also allows for deviations on both sides of the minima and for proportional benefits to accrue to banks depending on their levels of capitalization.

The parameters η_1 and v_1 are parameters that affect the marginal risk-based and leverage costs, respectively, of the bank's capital positions. The greater the magnitude of these parameters the higher will be the marginal costs faced by the bank.

The parameters $\hat{d}$ and $\hat{c}$ indicate the severity of the respective risk-based and leverage costs to the bank from operating with capital ratios very close to the minima. Banks will normally seek to ensure that there is an adequate buffer between the levels of their capital ratios and the recommended requirements. Therefore, within the model, banks realizing the stochastic nature of the evolution of their stock of capital, fix a buffer level to minimize the likelihood of not meeting the requirements.

The parameter α determines the rate of increase of adjustment costs whenever there is dis-equilibrium between the banks demand and supply of loans. The θ_1 parameter measures the net equity issuing marginal cost specification relative to the industry average. The θ_0 parameter is included to capture the fixed components of stamping and other legal costs associated with equity issuing. The net equity issuing variable, q_t, was proxied by changes in share capital with $\bar{q}$ becoming the industry average share capital growth for all banks over the entire sample period.

According to the functional forms specified, and setting $a = 1$,[23] the system for estimation reduces to:

$$\begin{aligned}
&\left(\frac{r_t^L - r_t^D}{1 - r_t^D}\right)\left(1 + \eta_1(k_t^R - (d + \hat{d}))^2 + v_1(k_t^L - (c + \hat{c})\right) - \left(\eta_0 - \frac{\eta_1}{3}(k_t^R - (d + \hat{d}))^3 + \eta_1(k_t^R - (d + \hat{d}))k_t^R\right) \\
&\quad - \left(v_0 - \frac{v_1}{3}(k_t^L - (c + \hat{c}))^3 + k_t^L v_1(k_t^L - (c + \hat{c}))^2\right) + q_t^2\theta_1(q_t - \bar{q}) - \left(l_t\alpha(l_t - \rho_t) + \frac{1}{2}\alpha(l_t - \rho_t)^2\right) \\
&\quad + \beta l_{t+1}\alpha(l_{t+1} - \rho_{t+1}) = u_{1,t}
\end{aligned} \tag{11}$$

[22] Cubic costs were preferred to the logarithmic specification of Furfine (2000) since they allow for a more drastic rate of increase in costs as the deviation from the minima increases

[23] Giving full weight to the components of L_t does not affect the generality of the derivations.

$$\left(\frac{r_t^S - r_t^D}{1 - r_t^D}\right)\left(1 + \eta_1(k_t^R - (d + \hat{d}))^2 + v_1(k_t^L - (c + \hat{c}))^2\right) - \left(v_0 - \frac{v_1}{3}(k_t^L - (c + \hat{c}))^3 + k_t^L v_1(k_t^L - (c + \hat{c}))^2\right) + q_t^2\theta_1(q_t - \bar{q}) = u_{2,t} \quad (12)$$

$$\left(\frac{1}{1 - r_t^D}\right)\left(r_t^D + \eta_1(k_t^R - (d + \hat{d}))^2 + v_1(k_t^L - (c + \hat{c}))^2\right) - q_t\theta_1(q_t - \bar{q}) - \left(\theta_0 + \frac{1}{2}\theta_1(q_t - \bar{q})^2\right) = u_{3,t} \quad (13)$$

The system (11)-(13) was estimated using Seemingly Unrelated Regression (SUR) since it was expected that there might be cross-equation correlation of the errors terms (i.e the expectation of the off-diagonal terms of the variance-covariance matrix may be non-zero). In addition an autoregressive structure of the error term was also included in each equation in order to minimize problems of serial correlation and thus improve the efficiency of the estimates. The discount factor, β, was chosen to be 0.975 corresponding with quarterly rate of time preference of 10 per cent.[24]

6.0 Empirical Results

Table 2 shows the results from the estimated system. Column (1) depicts the results excluding the error structure to account for the serial correlation and the crisis dummy. In addition to obtaining inefficient estimates, the errors displayed a high degree of serial correlation as evidenced by the Durbin-Watsun statistic. As shown in column (2), when the autoregressive error structure and crisis dummy are included, the system estimates improved and were more reflective of *a priori* expectations.

The adjustment cost parameter, α, is statistically insignificant in influencing profit-maximizing bank behaviour. This provides evidence that loan market discipline may not play such an important role in the profit maximizing plans of Jamaican banks. The marginal equity issuing cost parameter (θ_1) is also statistically insignificant at all conventional levels, reflecting the relative unimportance of equity issuing costs.

The null of lack of significance of the fixed leverage and risk-based requirement costs cannot be accepted at conventional significance levels. The estimates of $(\eta_0 + v_o)$ and v_0 do not differ significantly, suggesting that fixed costs incurred to meet the leverage requirement may be relatively more important to the banks maximization problem.

[24] Although the discount factor was chosen the parameter is in fact identified by the model and could have been estimated. It may be argued that the magnitude of the parameter is large compared to the actual for Jamaica, since interest rates are relatively high , but the results were identical with β value as low as 0.775.

The marginal costs of declining toward both minimum capital requirements are statistically significant. The marginal risk-based costs (η_1) outweigh marginal leverage costs (ν_1) in magnitude.[25] In practical terms, this suggests that banks are prepared to hold fewer risky assets such as loans relative to capital so as to increase their risk-based capital ratios and, hence, avert the costs of falling below the risk-based requirement. The positive sign on η_1 suggests that banks keep a relatively high buffer on their risk-based capital ratios in order to avoid potential regulatory costs. The magnitude and statistical significance of the $\hat{d}$ term supports this intuition.

The negative sign on the marginal leverage cost parameter appears at first to be counterintuitive. It suggests that banks actually reap a *net gain* from declining close to the leverage requirement. This is due to the significant opportunity cost in terms of high interest payments on securities foregone, net of the potential regulatory costs from declining below the minimum leverage requirement. Maintaining such high interest rate levels on securities would result in a declining loan demand as well as significant adverse selection problems in the loan market. On the other hand, the high interest rate regime has not proved to be an effective constraint on the Government's demand for funds. The buffer on the leverage ratio, $\hat{c}$, is not statistically different from zero indicating that banks do not find it profitable to keep leverage ratios in excess of the leverage requirement.

The results suggests that both leverage and risk-based capital requirements can significantly impact the long-run profit maximizing behaviour of Jamaican commercial banks and, as such, they represent important policy tools. At the margin, banks lose more from not adhering to the risk-based standard and hence are prepared to keep a higher buffer on their risk-based ratios to lower the probability of this occurring. To achieve this, banks will reduce their holdings of risky assets. If banks are prepared to reduce their loan holdings then this will have a dampening effect on production in the economy, as there are fewer funding alternatives for productive ventures.

With respect to the leverage requirement two interesting results were gained. Firstly, Jamaican banks are satisfied with a nominal buffer on this minimum requirement. This requirement is therefore more likely to be binding on commercial bank behaviour should regulatory authorities decide to increase the minimum standard for this ratio.

Secondly, there is a *marginal benefit* to declining close to the leverage requirement. This result is better understood against the background of the relatively high rates attached to Government of Jamaica default-free securities. In this context, commercial banks can reduce their marginal leverage costs if they

[25] In fact, the marginal leverage cost coefficient is negative.

hold a larger stock of these securities since the potential regulatory costs and the forgone interest earnings on loans are smaller than the gains from investing in default-free securities.

7.0 Conclusion

In conclusion therefore, the investigation suggests that both risk and leverage requirements affect significantly the profit maximizing behaviour of commercial banks in Jamaica. Interestingly, however, there appears to be a marginal benefit associated with not exceeding leverage requirements, which could be attributable to the high returns and low default- risk of securities relative to loans. This may have negative effects on funding for productive, private ventures and also for overall risk exposure of banks if there is significant interest rate risk. Additionally, the heavy concentration of default-free assets on bank balance sheets should cause greater concern given its implications for inadequate asset portfolio diversification as well as the current unsustainability of the public sector debt.

Even though it is desirable to apply capital adequacy measures more conducive to overall risk assessment, there is a real concern as to how the recent proposed changes to the Basle Accord (ie Basle II) could further impact the behaviour of Jamaican banks if the amendments are implemented. The "more stringent" risk standards could result in even greater contraction in the loan portfolios of banks. Within the context of Jamaica's emerging economy this could have "destabilising effects" during recessions, as during these periods the ratings of borrowers are affected. This suggests that the challenge to policy is to aim towards reducing interest rates on default-free securities so as to increase the scope for productivity as well as to improve the favourability of loans as an investment option for banks. Recommendations for improvement of the model are the inclusion of empirically estimated cost functions in the model, as well as improving the model to more fully capture the market risks associated with commercial banks.

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Figure 1.

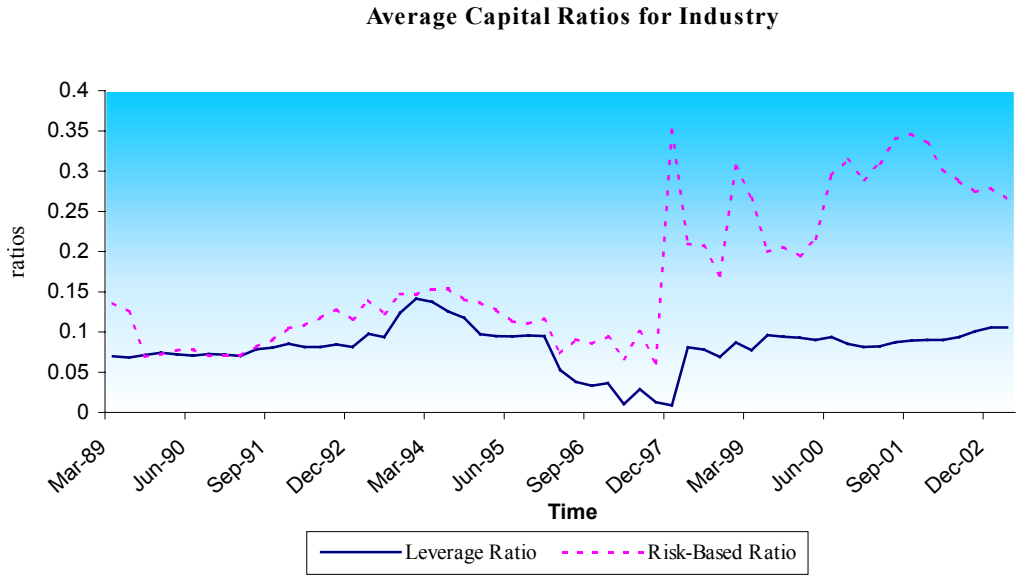

Figure 2.

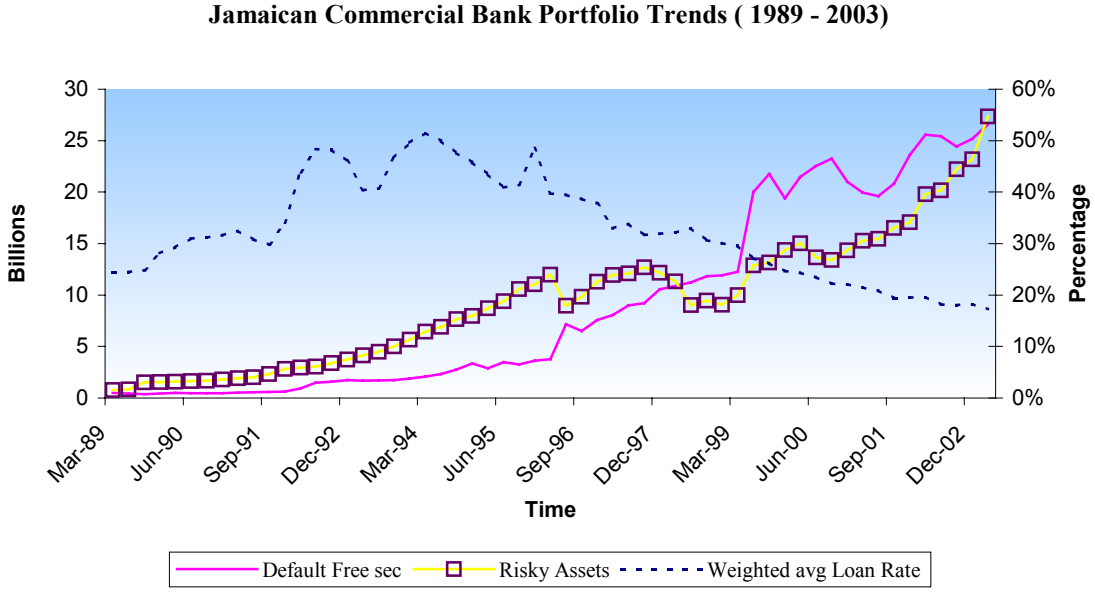

Table 1.

Parameter Estimates

Parameter	SUR Estimate without Crisis Dummy and Error Structure	SUR Estimate with Crisis Dummy and Error Structure
$(\eta_0 + v_o)$	-6.3297** (1.968)	0.0936** (0.0088)
v_0	6.3324** (1.968)	0.1199** (0.0126)
θ_0	0.8546** (0.0311)	-0.8788** (0.1341)
η_1	-0.1013** (0.0585)	1.005** (0.2542)
$\hat{d}$	0.396** (0.0214)	0.50814** (0.03696)
v_1	0.0137 (0.0149)	-0.7634** (0.1766)
$\hat{c}$	-20.1571 (6.100)	0.0354 (0.0608)
θ_1	16350.91 (35190.61)	-5.670 (6.70)
α	-4.6500 (0.000)	0.000 (0.00)

(i) Standard errors are placed in parentheses.
(ii) **signify statististical significance at the 1% level

Table 2.

Risk Based Capital Weights

Category	Risk Weights (%)
On Balance Sheet Items	
Cash in Hand	0
Due from BOJ	0
Items in Course of Collection	0
Securities Purchased	0
Jamaica Government Securities	0
Other Public Sector Securities	0
Items in the Course of Collection (banks)	20
Due from Comm. Banks	20
Due from Deposit Taking Institutions	20
Other Investments	100
Loans	100
Accounts Receivables	100
Fixed Assets (Net)	100
Other Assets	100
Off Balance Sheet Items	
Accepts., Guarantees	100
Other Confirmed Paper	100
Unused Lines of Credit	100
Undisbursed Loans	100
Commitments	100
Foreign Currency Items	
Notes and Coins	0
Cash Reserves	0
Items in Course of Collection	0
Foreign Currency Due From Comm. Banks	20
Foreign Currency Due From Other Financial Institutions	20
Foreign Securities	100
Foreign Currency loans	100
Other Foreign Currency Denominated Assets	100