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Differential Capital Requirements: Leverage Ratio versus Risk-Based Capital Ratio from a Monitoring Perspective

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In this paper, I attempt to amalgamate the study of leverage-ratio performance with the monitoring decisions of a profit-maximizing bank. Applying tools used in studying the industrial organization of banking, my paper serves as a first step to tying the performance differences between the leverage and risk-based constraints to the more fundamental issue of monitoring. Does a bank faced with a leverage-based capital constraint monitor its loans better than a bank under a risk-based capital constraint? In a market that is characterized by a dominant bank and fringe banks, I seek to understand if the dominant bank monitors its loan when faced with a Basel III–style leverage ratio. The results show that under certain parameter ranges, the dominant bank will monitor its portfolio when faced with a leverage-based capital constraint. The results also show that the dominant bank will not monitor its portfolio when faced with a risk-based capital constraint.

Keywords: Differential capital requirements, dominant-bank model, bank loan monitoring.

JEL Code: G2.

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*"The leverage ratio is an overly simplistic capital measure….[s]o why the love affair with the leverage ratio?"- **James Chessen, Chief Economist for the American Bankers Association***

*"I must confess to being one of those bank supervisors who has a love affair with the leverage ratio….[I]t is an understandable measure of a bank's loss absorption capacity that can be compared across firms." - **Esther George, President and CEO of the Federal Reserve Bank of Kansas City***

1. Introduction

Regulatory capital standards have undergone tremendous amount of change in the past decades. Over time, regulators have gone back and forth on the issue of the type of capital standards and constraints that would ensure the soundness of the banking system. In the early 1980s, banking regulators utilized a leverage requirement and required banks to maintain a fixed minimum amount of capital relative to total assets. (Gilbert et al. (1985) and Alfriend (1988)). However, the leverage ratio proved to be risk insensitive. In 1988, U.S. bank regulators adopted the Basel I risk-based capital standards which were somewhat coarse and rudimentary. The revised Basel II Accord of 2004 sought more granularity by looking at risk weights from a credit rating approach and concurrently adopting the internal ratings based approach (IRB) that allowed banks to use their own proprietary internal risk models to determine their minimum capital requirements. (Basel (2004, 2006)). However, the 2008 financial and banking crisis showed that the risk based capital constraints were quite impotent in ensuring bank health.

As Haldane and Madouros (2012) point out, simple weighted measures such as leverage ratios appeared to have better pre-crisis predictability than risk based approaches. There have been several empirical studies such as Demirguc-Kunt et al. (2010) and Estrella et al. (2000) that show that leverage ratios perform better. Mariathasan and Merrouche (2014) have shown empirically that banks that rely on internal risk models and risk based ratios tend to have risk based capital that is low and risk weights that are inadequate. Their

study provides empirical support to gaming or what they call strategic risk-modelling. Theoretical work by Blum (2007) and Bischel and Blum (2005) show that a risk-independent leverage ratio is necessary to induce truthful risk reporting. The results of my paper align with these findings.

In this paper, I attempt to fuse the study of leverage ratio performance with monitoring of a profit maximizing bank. Using tools used in studying the industrial organization of banking my paper serves as a first step to tying the performance differences between the leverage and risk based constraints to the fundamental issue of monitoring. . Does a bank faced with a leverage based capital constraint monitor its loans better than under a risk based capital constraint ? In a market that is faced by dominant bank and fringe banks, I seek to understand if the dominant bank monitors its loan when faced with a Basel III style leverage ratio. The results of my study shows under certain parameter ranges, the dominant bank will monitor its portfolio when faced with a leverage based capital constraint. The dominant bank will not monitor its portfolio when faced with a risk based capital constraint.

The dominant-bank model with differential capital requirements for the dominant and fringe banks is presented in the next section (Section 2). In Section 3, I present the simulation results for the model where the dominant bank faces a leverage ratio and fringe banks face a risk based capital ratio. Section 4 presents simulation results. Section 5 summarizes our results and evaluates their implications for future research.

2. The Banking Model and Analytical Solution

In this paper, I adopt the banking model of VanHoose (2013, 2010, and 1985) whereby the profit function for an individual bank *i* is given as follows:

$$\pi_i = (1 - \alpha\delta_i) r_L L_i + r_S S_i - r_F F_i - r_D D_i - r_E E_i$$
$$- \left(\frac{\omega_i + \beta c_i}{2} \right) L_i^2 - \frac{\psi_i}{2} S_i^2 - \frac{\upsilon_i}{2} F_i^2 - \frac{\xi_i}{2} D_i^2 - \frac{\sigma_i}{2} E_i^2, \quad (1)$$

$i = f$, refers to the fringe bank and $i = d$ refers to the dominant bank. The parameters of the model are defined as follows:

$L_i \equiv$ Loans that earn the loan rate r_L
$S_i \equiv$ Security holdings that earn the rate r_S;
$F_i \equiv$ Net wholesale funds borrowings obtained at the rate r_F ;
$D_i \equiv$ Deposits obtained at the rate r_D ;
$E_i \equiv$ Bank equity obtained at the rate r_E;
$\delta_i \equiv$ Per-dollar deadweight loan default loss that is a small but positive fraction;
$\omega_i \equiv$ Marginal cost of lending
$c_i \equiv$ Monitoring cost
$\psi_i \equiv$ Marginal cost of securities
$\nu_i \equiv$ Marginal cost of wholesale funds
$\xi_i \equiv$ Marginal cost of issuing deposits
$\sigma_i \equiv$ Marginal cost of equity capital
$\rho \equiv$ Required reserve ratio
$\alpha \equiv 0$ *if bank decides to monitor*
1 *if bank does not monitor*
$\beta \equiv 1$ *if bank decides to monitor*
0 *if bank does not monitor*

Positive values of $\omega_i, \psi_i, \upsilon_i, \xi_i,$ and σ_i ensure upward-sloping marginal resource costs of lending, managing a securities portfolio, trading wholesale funds, issuing deposits, and obtaining equity capital, which by assumption are separable marginal costs. α and β are indicator parameters that take on values of either zero or unity depending on the prevailing circumstances for the bank. The pairing of α and β values indicates whether or not the bank monitors its loans to prevent the realization of the per-dollar deadweight loan default

loss. If $\alpha = 0$ and $\beta = 1$, the bank incurs a monitoring cost equal to $\frac{c_i}{2} L_i^2$ and thereby fully eliminates any occurrence of a default loss. In contrast, if $\alpha = 1$ and $\beta = 0$, then the bank opts not to monitor its loan portfolio, in which case it experiences the full amount δ_i of this loss.

The profit maximizing bank faces two constraints. The first is its binding balance-sheet constraint, $L_i + S_i = (1 - \rho) D_i + F_i + E_i$, where ρ is the required reserve ratio. The second is an assumed binding capital-requirement constraint. I assume in this section that if the institution is a large, dominant bank, it faces a Basel III-style, leverage-ratio constraint based on the bank's total assets, which equal the sum of loans and securities:

$$E_i = \Gamma (L_i + S_i), \tag{2}$$

where Γ is required leverage-based capital ratio of 6 percent. If the institution is a small, fringe bank, it confronts a Basel II-style, risk-based capital constraint:

$$E_i = \theta L_i, \tag{3}$$

where θ is the required risk-based capital ratio of 4.5 percent.

Consequently, there are two cases to be considered: (1) the case of the dominant bank facing a binding leverage-based capital regulation constraint, either with a decision to monitor its loans ($\alpha = 0$ and $\beta = 1$) or with a choice not to monitor its loans ($\alpha = 1$ and $\beta = 0$). (2) The case of a fringe bank confronting a binding risk-based capital regulation constraint with a decision to monitor its loans ($\alpha = 0$ and $\beta = 1$) or with a choice not to monitor its loans ($\alpha = 1$ and $\beta = 0$).

In each case, the analysis applies to a banking market with a dominant bank and fringe competitors. For the market's dominant bank ($i = d$), the first-order conditions for maximum profits in (1) yields

$$\left(1-\alpha\delta_d\right)r_L-\left(\omega_d+\beta c_d+\sigma\Gamma^2\right)L_d=MC_d\equiv r_F+\nu_d F_d\equiv MFC_d=r_{Di}+\xi_d D_d, \tag{4}$$

where the per-dollar expense in the wholesale funds market takes on both the role of the marginal cost of lending and the valuation of the marginal factor cost of funds at the profit-maximizing quantity of deposits. As shown in VanHoose (2013), which in turn draws from Blair and Harrison (2010), the semi-reduced-form solution for the prevailing loan rate established by the dominant bank in the presence of a competitive fringe is given by

$$r_L=\left(\frac{\eta-\phi\left(1-s_L\right)}{\eta-\phi\left(1-s_L\right)+s_L}\right)\left(r_F+\upsilon_d F_d\right)\equiv\Lambda\left(r_F+\upsilon_d F_d\right), \tag{5}$$

where s_L is the dominant bank's share of total market lending, η (< -1) is the price elasticity of overall market loan demand, ϕ (> 0) is the price elasticity of loan supply for the competitive fringe, and $r_F+\upsilon_d F_d$ is the dominant bank's per-dollar cost of funds, and $\Lambda \geq 1$. The semi-reduced-form solution for the deposit rate is

$$r_D=\left(\frac{\varepsilon-\zeta\left(1-s_D\right)}{\varepsilon-\zeta\left(1-s_D\right)+s_D}\right)\left(r_F+\upsilon_d F_d\right)\equiv\Omega\left(r_F+\upsilon_d F_d\right), \tag{6}$$

where s_D is the dominant bank's share of total market deposit funds, ε (>1) is the price elasticity of supply of the overall market supply of deposit funds, ζ (<0) is the price elasticity of demand for deposit funds on the part of the competitive fringe, and $0<\Omega\leq 1$. I consider a setting in which the dominant bank faces exactly the same set of fringe banks in both the loan and deposit markets, so that $s_L=s_D=s$.

The solutions for the dominant bank's profit-maximizing balance-sheet quantities in the face of a binding leverage-ratio capital constraint are reported in Table 1. These solutions indicate, naturally, that a monitoring dominant bank's balance-sheet choices depend in part on the magnitude of the marginal monitoring cost parameter c_d, while a non-monitoring dominant bank's decisions are influenced by the size of the loan default

loss, δ_d, to which it allows its profits to be adversely exposed. Either a monitoring or non-monitoring bank's balance-sheet choices depend on the other structure parameters, including the leverage-based capital-requirement ratio, Γ, that applies only to the dominant bank. Thus, when the dominant bank makes a decision about whether to monitor its loans based on a comparison of profits with and without monitoring, all of these parameters influence its monitoring decision.

Table 1 Goes Here

Substitution of the solution for the dominant bank's optimal net wholesale-funds borrowing position into (5) and (6) yields interdependent expressions for the market loan and deposit rates set by the dominant bank in light of the presence of the competitive fringe. Solving these expressions jointly ultimately yields the reduced-form solutions for the loan and deposit rates reported in Table 2. Both the market loan rate and the market deposit rate depend positively on the security rate and negatively on the rate of return on equity and the wholesale-funds rate, with the loan rate related to these rates through the markup parameter Λ and the deposit rate related to them through the markdown parameter Ω. All other structural parameters influence the retail loan and deposit rates established by the dominant bank including the leverage-based capital requirement ratio, Γ.

Table 2 Goes Here

Table 3 displays the optimal balance-sheet choices of a fringe bank. Like the dominant bank, the fringe bank's decisions depend on the various interest rates, with responses to changes in each of these interest rates dependent on the structural parameters applicable to the fringe bank. The solutions in Table 3 indicate that, as in the case of the dominant bank, a monitoring fringe bank's balance-sheet choices depend in part on the size

of the marginal monitoring cost parameter that applies for fringe banks, c_f. In contrast, a non-monitoring fringe bank's decisions depend in part on the loan default loss, δ_f, that it faces.

Table 3 Goes Here

Among the parameters influencing the balance-sheet choices of fringe banks is the risk-based capital requirement ratio, θ, imposed on the fringe banks by the regulator. Nevertheless, because the leverage-based ratio, Γ, that the regulator imposes on the dominant bank influences the market loan and deposit rates, fringe banks also are indirectly affected by the magnitude of the leverage-based capital-requirement ratio as well. When I compare fringe bank profits with and without monitoring to determine whether the bank monitors its loans, structural parameters for both dominant and fringe banks influence their monitoring choice. Both capital-requirement ratios affect their monitoring decisions.

3. Simulation of the Model with a Leverage- Ratio-Constrained Dominant Bank and Risk Based –Ratio Constrained Fringe Bank

I conduct simulations to evaluate the model's implications when the dominant banks face the leverage ratio and fringe banks face a risk based capital constraint. I begin with the parameter configuration reported in Tables 4, which I refer to as the initial baseline case; these choices are similar to those considered in other studies, such as Kopecky and VanHoose (2006) and VanHoose (2013). An additional assumption utilized throughout the remainder of the paper is that the required reserve ratio, ρ, is at the 10 percent level.

Table 4 Goes Here

The top panel of Figure 1 displays the differential between the dominant bank's profits without monitoring and its profits with monitoring given the parameter

configuration specified in Table 4. To compute the dominant bank's profits without and with monitoring, these parameter values were substituted into the solutions for the dominant bank's profit-maximizing balance-sheet choices listed in the appropriate columns of Table 1. The resulting values of the dominant bank's loans, securities, deposits, and equity were then substituted, along with the corresponding loan rate and deposit rate levels resulting from insertion of the parameter values into the solutions for these rates in Table 2, into the dominant bank's profit functions without and with monitoring. The top panel of Figure 1 then displays the differential between the resulting profit levels at alternative market shares for the dominant bank. This non-monitoring/monitoring profit differential is negative below roughly a 91 percent market share for the dominant bank, which implies that that for our baseline parameters, the dominant bank receives higher profits when it monitors over this range of market shares. Above this market share, however, the profit differential is positive, which indicates that the dominant bank will receive higher profits by opting not to monitor above this market share. Hence, a more nearly monopolistic dominant bank is less likely to opt to monitor than one that faces a greater threat of competition from banks in the competitive fringe.

Figure 1 Goes Here

The key reason for the J-curve shape of the non-monitoring/monitoring profit differential in relation to the dominant bank's market share is that the spread between the loan and deposit rates widens as this market share increases. A higher market share for the dominant bank boosts the loan-rate markup while simultaneously reducing the deposit-rate markdown. This fact means that if the bank opts not to monitor, the proportionate effect on the dominant bank's profits of the loan default loss δ_d, the value of which is invariant to

the dominant bank's market share, diminishes as that market share rises in value. At the same time, however, even as the higher loan-rate markup boosts a monitoring dominant bank's profits with a larger market share, its total monitoring expenses increase as its aggregate loan portfolio expands with a rise in that share. This fact leads to the J-curve shape: As the dominant bank's market position moves closer toward monopoly, the diminishing profit effect of the default loss together with a growing monitoring expense tend to push it toward experiencing a net profit gain from shifting from a monitoring stance to opting not to monitor. These fundamental effects account for the tendency of this J-curve shape of this relationship to be maintained across most of the simulations I consider even as variations in values of specific parameters otherwise alter the position and shape of the non-monitoring/monitoring profit differential.

The bottom panel of Figure 1 indicates that for our baseline set of parameters, fringe banks always choose not to monitor at any level of the market share held by the dominant bank. The relationship between the spread between the loan and deposit rates vis-à-vis the dominant bank's market share spills over as Ill onto the fringe banks' monitoring choice, resulting in a generally J-curve shape as Ill for the relationship between fringe banks' profits and this market share.

Not surprisingly, banks' monitoring choices are sensitive to the values of the monitoring cost parameters c_d and c_f. The two panels of Figure 2 illustrate the effects of concurrent reductions in the value of the dominant bank's monitoring-cost parameter c_d from its baseline value of 0.002 to 0.001 and in the fringe bank's parameter c_f from its baseline value of 0.002 to 0.0015. A comparison of the top pane in Figure 2 with the corresponding panel in Figure 1 indicates that this decrease in the value of c_d is sufficient,

holding all other parameters in the initial baseline simulation unchanged, to yield higher profits for the dominant bank that it opts to monitor over the depicted range of market shares. Comparing the lower panel of Figure 2 with the corresponding panel of Figure 1 shows that the contemplated reduction in the value of c_f is sufficient to yield higher fringe-bank profits under monitoring for dominant-bank market shares below about 0.7. At higher market shares for the dominant bank, however, the spread between the loan rate and the deposit rate established by the dominant bank is sufficiently large that the fringe bank's profits are higher if it opts not to monitor.

Figure 2 Goes Here

Likewise, variations in the value of the deadweight default loss parameters δ_d and δ_f alter the banks' monitoring incentives. Figure 3 shows the effects, relative to the set baseline case depicted in Figure 1, on the banks' non-monitoring/monitoring profit differentials of simultaneous increases in the dominant bank's loan-loss parameter δ_d from 0.005 to 0.01 and in the fringe bank's loan-loss parameter δ_f from 0.006 to 0.015. Comparing the top panel of Figure 3 with the corresponding panel of Figure 1 indicates that in the face of such a substantial increase in exposure to loan losses, the dominant bank will shift to choosing a monitoring status over all relevant ranges of its market share. In addition, a comparison of the bottom panel of Figure 3 with the corresponding panel of Figure 1 shows that fringe banks reach to the significant rise in loan-loss exposure by opting to monitor up to a dominant-bank market share just over 0.8. Once again, as the dominant bank's market share rises beyond this level, the spread between the loan and deposit rates established by the dominant bank becomes sufficiently wide to push a fringe bank's non-monitoring profits above its profits with monitoring. Thus, at market shares

higher than this level, fringe banks choose not to monitor.

Figure 3 Goes Here

Other parameters that have notable effects on the dominant bank's monitoring incentives include the equity cost parameters, σ_d and σ_f, and the rate of return on equity, r_E. Decreases in the values of and of these parameters boost both lending and profits for given values of monitoring-cost and loan-loss parameters and other parameters, which generates outcomes qualitatively analogous to those depicted in Figures 2. Increases in the values either of σ_d and σ_f or of r_E bring about outcomes qualitatively similar to Figure 3.

Figure 4 displays the effects on the banks' non-monitoring/monitoring profit differentials of increasing the binding leverage-based capital requirement ratio, Γ. The higher capital requirement ratio gives the dominant bank an incentive to reduce its asset portfolio and to raise its equity capital, *ceteris paribus*, which diminishes the bank's profits whether or not it monitors. Comparing the top panel of Figure 4 with the corresponding panel of Figure 1 indicates that raising this capital ratio generates a greater profit reduction in profits if the dominant bank chooses to monitor, with the profit-differential reduction being generated mainly via the resulting drop in the bank's lending that causes overall monitoring costs to drop and monitoring profits to rise.

Figure 4 Goes Here

Comparing the bottom panel of Figure 4 with that of Figure 1 shows that within the model, a tightening of leverage-based capital ratio faced by the dominant bank has virtually no spillovers onto the fringe banks. This is so because the effects of the increase in the leverage ratio imposed on the dominant bank have meager effects on the spread between

the loan rate and deposit rate confronting the fringe banks. Given the underlying assumption that no other parameters faced by the fringe banks have changed, their monitoring incentives otherwise remain unaffected.

4. Simulations of Risk-Based-Capital-Constrained Dominant and Fringe Banks

Prior to the adoption of Basel III's leverage-based capital requirements for large banks, both the dominant and fringe banks tended most often to be constrained by the risk-based capital requirement ratios established under the Basel I and II frameworks. In this section, therefore, I consider an altered version of the model in which the dominant bank's portfolio choices are determined analogously to those of Section 3's fringe banks. In this setting, the optimal balance sheet choices of the dominant bank have the same forms of those reported in Table 3 but with the dominant-bank parameters replacing the fringe-bank parameters. For this case, in which the risk-based-capital-constrained dominant bank establishes the loan and deposit rates, the solutions for these rates reported in Table 5 apply.

Figure 5 Goes Here

The top panel of Figure 5 displays the differential between the dominant bank's profits without monitoring and its profits with monitoring given the parameter configuration specified in Table 6. To compute the dominant bank's profits without and with monitoring, these parameter values were substituted into the solutions for the dominant bank's profit-maximizing balance-sheet choices listed in the appropriate columns of Table 3. The resulting values of the dominant bank's loans, securities, deposits, and equity were then substituted, along with the corresponding loan rate and deposit rate levels resulting from insertion of the parameter values into the solutions for these rates in Table 5, into the dominant bank's profit functions without and with monitoring. The top

panel of Figure 1 then displays the differential between the resulting profit levels at alternative market shares for the dominant bank. This non-monitoring/monitoring profit differential is positive for all ranges of market share. This implies that that for our baseline parameters, the dominant bank receives higher profits when it does not monitor over the entire range of market shares. Hence, a risk based capital constraint results in no monitoring by the dominant bank. The bottom panel of Figure 5 indicates that for our baseline set of parameters on Table 6, fringe banks always choose not to monitor at any level of the market share held by the dominant bank.

When comparing this outcome with that seen in Table 1, we find that under certain conditions and parameters, a risk-based capital constraint imposed on both the dominant bank and fringe banks mitigates monitoring. This result implies that that under certain parameter vales, the leverage-ratio capital constraint performs better in inducing monitoring in a dominant bank.

5. Conclusion and Policy Implications

Moving forward from a Basel I and II into a Basel III framework, banks are poised to face differential capital requirements under the Basel III regime. In this paper, I adopt a simple bank balance sheet model to uncover the implications of differential capital constraints and its impact on the banks' monitoring decision. Given that the Basel III leverage ratio will impact the biggest banks first, I segment my banking market into one that consists of a dominant bank(s) and fringe banks and consider two scenarios. In my first scenario, the dominant bank faces a leverage ratio while the fringe bank faces a risk-based capital ratio. Under this first scenario and certain parameter values, we find that the dominant bank is induced to monitor its loans while the fringe does not monitor. In the

second scenario, both dominant and fringe banks face a risk-based capital constraint. In this scenario and specific parameter values, I find that the dominant bank fails to monitor regardless of its market share. The model employed in this paper uses a very simple balance sheet model. Hence, one needs to be careful in stretching the policy implications. However, under certain parameter values and ranges, this paper finds that the leverage ratio induces better monitoring outcomes for dominant bank(s). We do not see it inducing monitoring outcomes for the fringe banks.

This paper does not suggest that the leverage ratio should exclude other risk-based capital constraints. However, given some of the deficiencies in risk-based ratios, this paper points to the direction that dominant banks(s) are likely to monitor under a binding leverage based capital constraint and that leverage based capital constraint could potentially help measure the dominant banks' loss absorption capacity across large banking firms.

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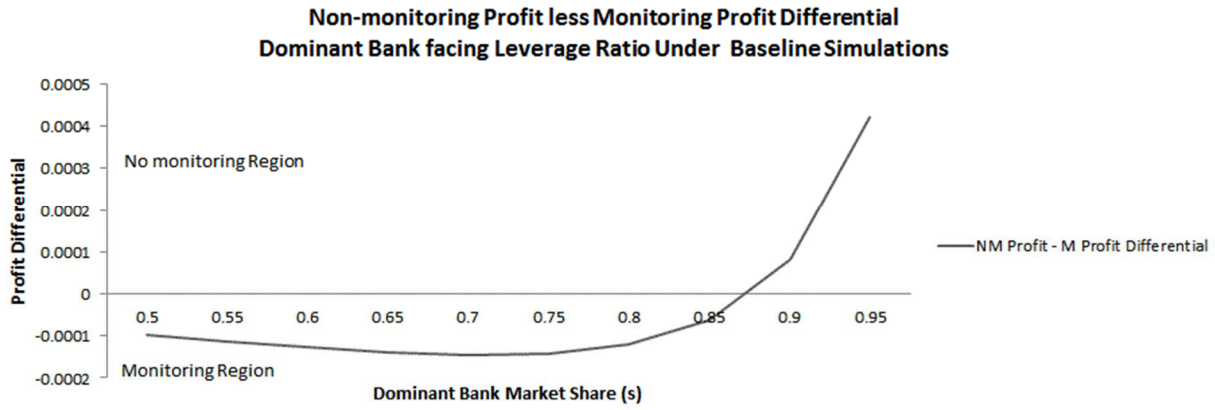
Figure 1: Baseline Simulation of Profit Differentials for Leverage-Based-Capital-Ratio-Constrained Dominant Bank and Risk-Based-Capital-Ratio-Constrained Fringe Banks



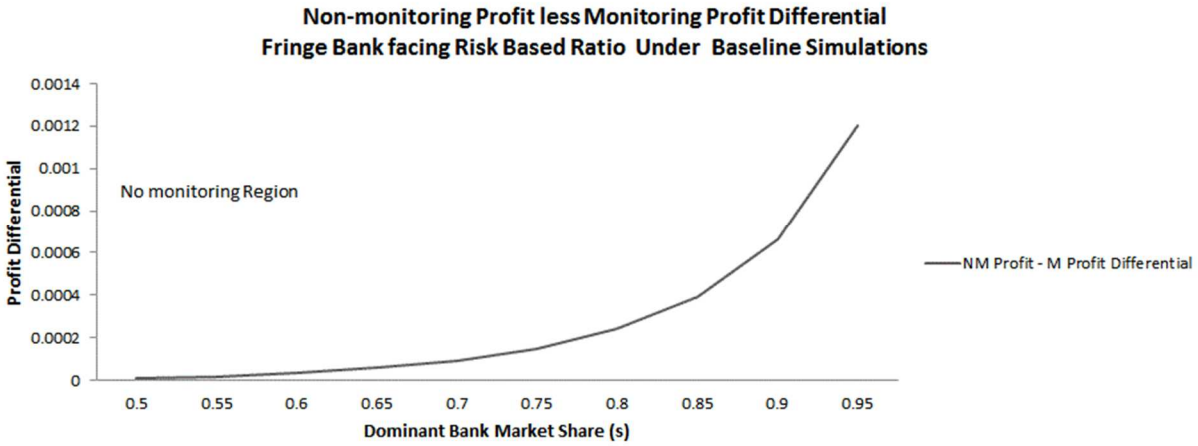
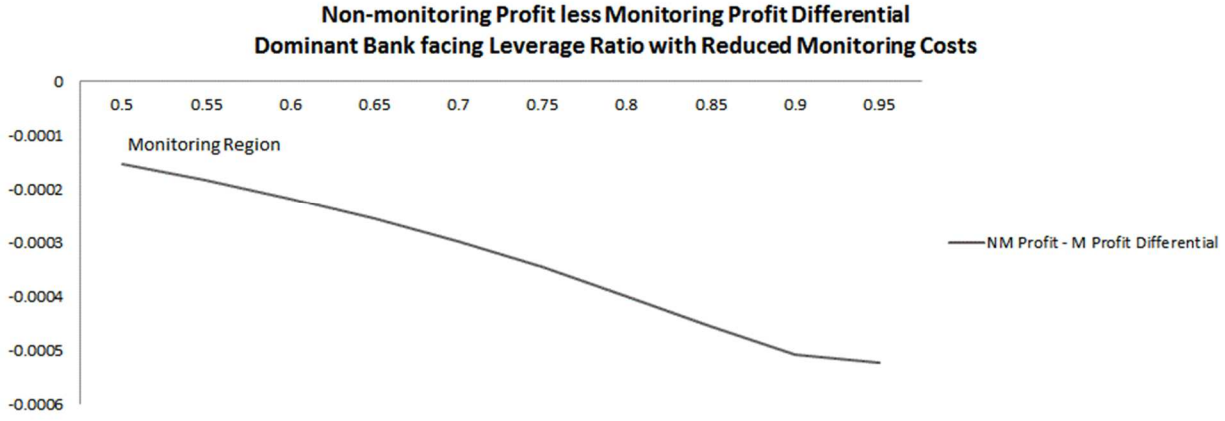


Figure 2: Simulations for Leverage-Based-Capital-Ratio-Constrained Dominant Bank and Risk-Based-Capital-Ratio-Constrained Fringe Banks: Monitoring Cost Parameter c Reduced to 0.001 for Dominant Bank and to 0.0015 for Fringe Firms



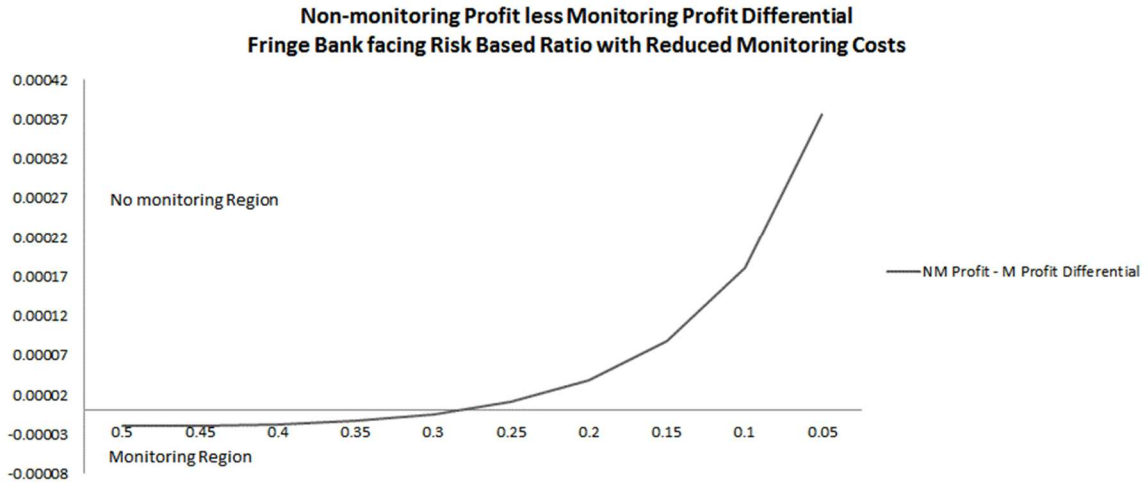
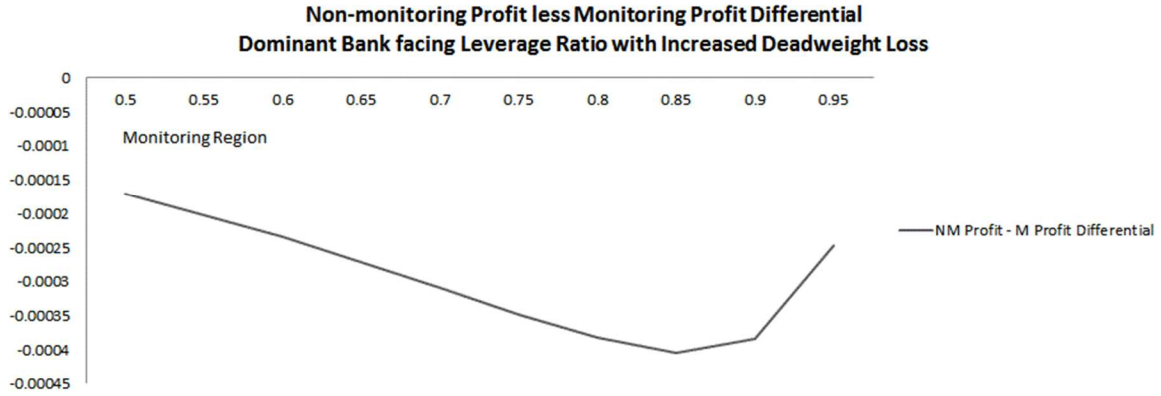


Figure 3: Simulations for Leverage-Based-Capital-Ratio-Constrained Dominant Bank and Risk-Based-Capital-Ratio-Constrained Fringe Banks: Deadweight Loss Parameter δ Increased to 0.01 for Dominant Bank and to 0.015 for Fringe Firms



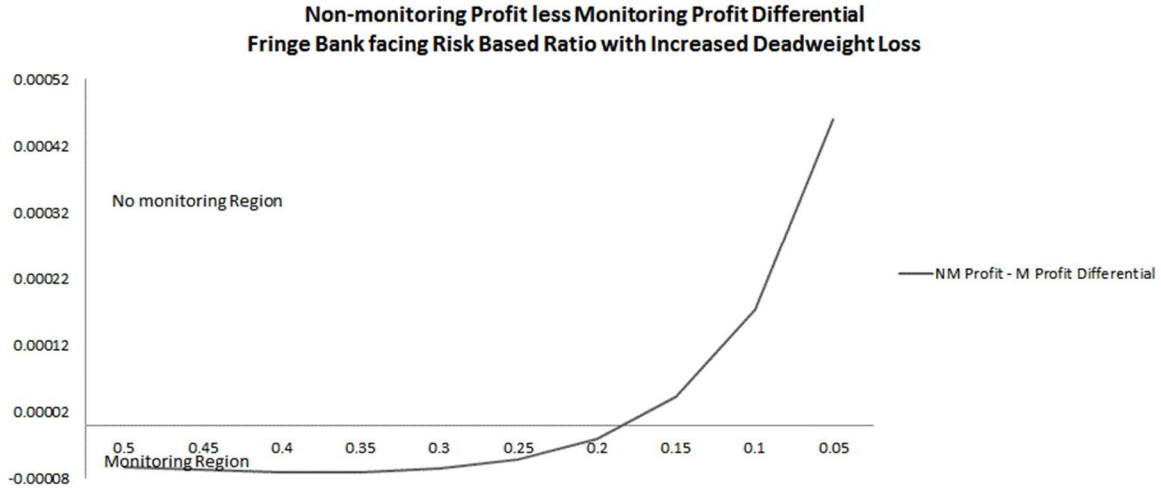
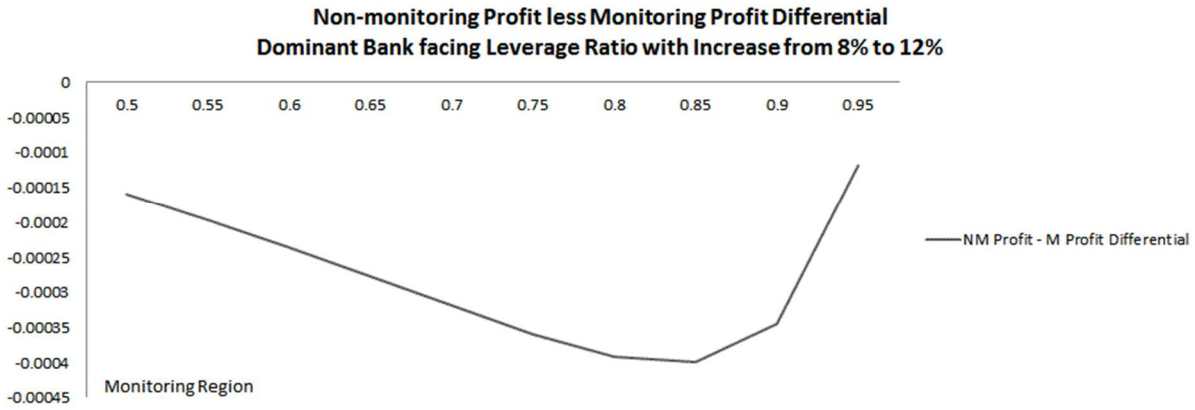


Figure 4: Simulations for Leverage-Based-Capital-Ratio-Constrained Dominant Bank and Risk-Based-Capital-Ratio-Constrained Fringe Banks: Leverage-Based Capital Ratio Γ Faced by the Dominant Bank Raised from 0.08 to 0.12



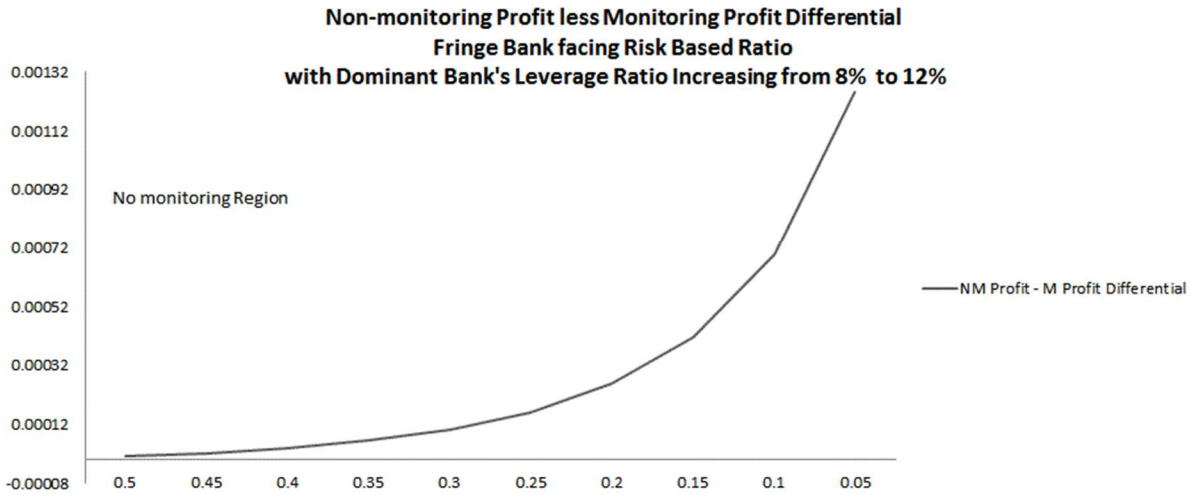
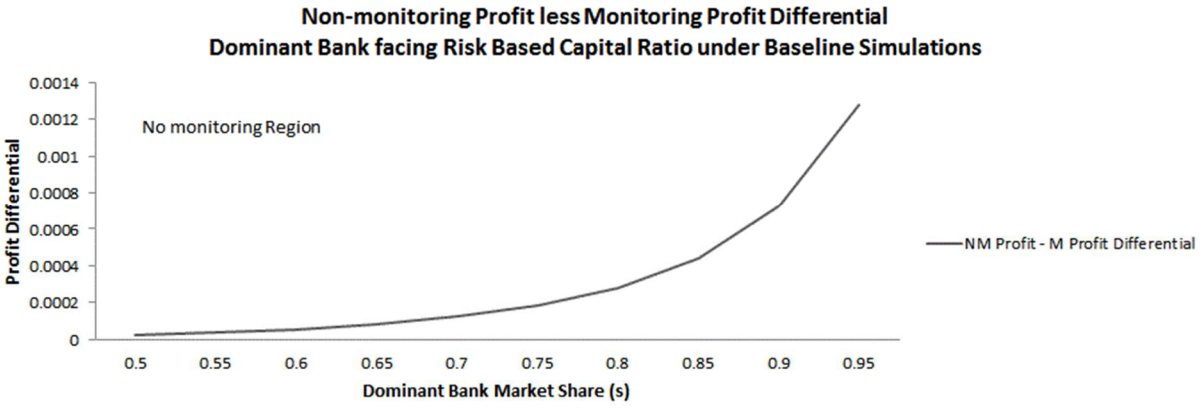


Figure 5: Baseline Simulation of Profit Differentials for Risk-Based-Capital-Ratio-Constrained Dominant Bank and Risk-Based-Capital-Ratio-Constrained Fringe Banks



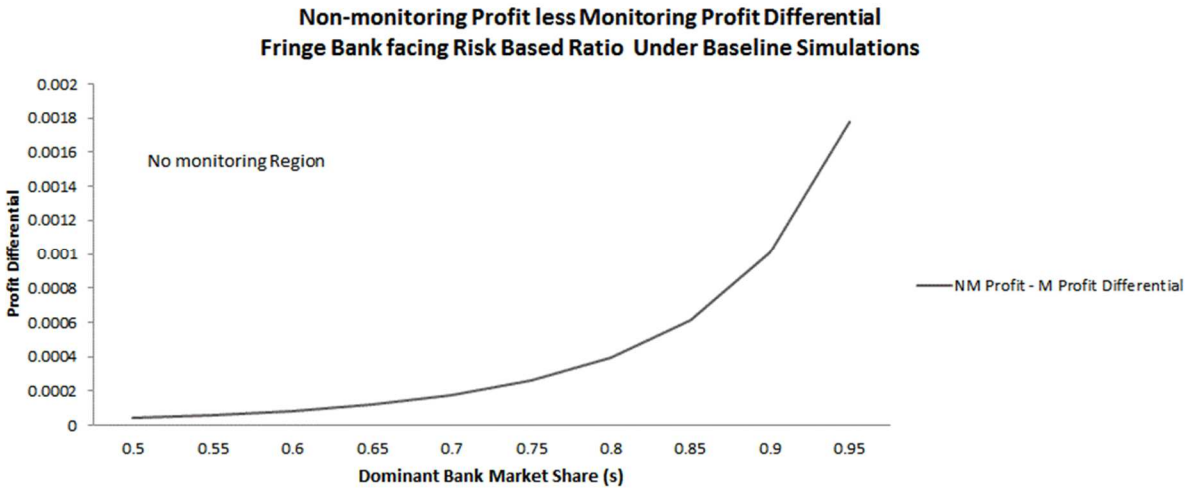


Table 1: Optimal Balance Sheet Choices for Leverage-Based-Capital-Ratio-Constrained Dominant Bank

	Solution under Monitoring ($\alpha = 0$ and $\beta = 1$)	**Solution without Monitoring ($\alpha = 1$ and $\beta = 0$)**
Loans	$L_d^M = \hat{\Delta}_d^{-1}\left(\hat{l}_{d,L} r_L - \hat{l}_{d,S} r_S - \hat{l}_{d,E} r_E - \hat{l}_{d,D} r_D - \hat{l}_{d,F} r_F\right)$, where $\hat{l}_{d,L} \equiv \left(\psi_d + \sigma_d \Gamma^2\right)\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2$; $\hat{l}_{d,S} \equiv \left(\sigma_d \Gamma^2\right)\left\{\left(\psi_d + \sigma_d \Gamma^2\right)\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2\right\}$; $\hat{l}_{d,E} \equiv (1-\Gamma)\psi_d \xi_d$; $\hat{l}_{d,D} \equiv (1-\Gamma)(1-\rho)\psi_d \upsilon_d$; $\hat{l}_{d,F} \equiv \left[(1-\rho)^2 \sigma_d + \xi_d\right]\psi_d \Gamma$; and $\hat{\Delta}_d \equiv \upsilon_d \left\{\begin{array}{l} \xi_d (1-\Gamma)^2 (\omega_d + c_d + \psi_d) \\ +(1-\rho)^2\left[(\omega_d + c_d + \psi_d)\sigma_d \Gamma^2 + (\omega_d + c_d)\psi_d\right] \end{array}\right\}$ $+\xi_d\left[(\omega_d + c_d + \psi_d)\sigma_d \Gamma^2 + (\omega_d + c_d)\psi_d\right]$	$L_d^{NM} = \tilde{\Delta}_d^{-1}\left(\tilde{l}_{d,L} r_L - \tilde{l}_{d,S} r_S - \tilde{l}_{d,E} r_E - \tilde{l}_{d,D} r_D - \tilde{l}_{d,F} r_F\right)$, where $\tilde{l}_{d,L} \equiv (1-\delta_d)\left\{\left(\psi_d + \sigma_d \Gamma^2\right)\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2\right\}$; $\tilde{l}_{d,S} \equiv \left(\sigma_d \Gamma^2\right)\left\{\left(\psi_d + \sigma_d \Gamma^2\right)\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2\right\}$; $\tilde{l}_{d,E} \equiv (1-\Gamma)\psi_d \xi_d$; $\tilde{l}_{d,D} \equiv (1-\Gamma)(1-\rho)\psi_d \upsilon_d$; $\tilde{l}_{d,F} \equiv \left[(1-\rho)^2 \sigma_d + \xi_d\right]\psi_d \Gamma$; and $\tilde{\Delta}_d \equiv \upsilon_d \left\{\begin{array}{l} \xi_d (1-\Gamma)^2 (\omega_d + \psi_d) \\ +(1-\rho)^2\left[(\omega_d + \psi_d)\sigma_d \Gamma^2 + \omega_d \psi_d\right] \end{array}\right\}$ $+\xi_d\left[(\omega_d + \psi_d)\sigma_d \Gamma^2 + \omega_d \psi_d\right]$
Securities	$S_d^M = \hat{\Delta}_d^{-1}\left(\hat{s}_{d,L} r_L + \hat{s}_{d,S} r_S - \hat{s}_{d,E} r_E + \hat{s}_{d,D} r_D + \hat{s}_{d,F} r_F\right)$, where $\hat{s}_{d,L} \equiv \sigma_d \Gamma^2\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2$; $\hat{s}_{d,S} \equiv \left(\omega_d + c_d + \sigma_d \Gamma^2\right)\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2$; $\hat{s}_{d,E} \equiv (\omega_d + c_d)\left[\xi_d + (1-\rho)\psi_d\right]\Gamma$; and $\hat{s}_{d,D} \equiv (1-\Gamma)(1-\rho)(\omega_d + c_d)\upsilon_d$; $\hat{s}_{d,F} \equiv (1-\Gamma)(\omega_d + c_d)\xi_d$	$S_d^{NM} = \tilde{\Delta}_d^{-1}\left(\tilde{s}_{d,L} r_L + \tilde{s}_{d,S} r_S - \tilde{s}_{d,E} r_E + \tilde{s}_{d,D} r_D + \tilde{s}_{d,F} r_F\right)$, where $\tilde{s}_{d,L} \equiv (1-\delta_d)\left\{\sigma_d \Gamma^2\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2\right\}$; $\tilde{s}_{d,S} \equiv \left(\omega_d + \sigma_d \Gamma^2\right)\left[(1-\rho)^2 \upsilon_d + \xi_d\right] + \upsilon_d \xi_d (1-\Gamma)^2$; $\tilde{s}_{d,E} \equiv \omega_d\left[\xi_d + (1-\rho)\psi_d\right]\Gamma$; $\tilde{s}_{d,D} \equiv (1-\Gamma)(1-\rho)\omega_d \upsilon_d$; $\tilde{s}_{d,F} \equiv (1-\Gamma)\omega_d \xi_d$

Deposits	$D_d^M = \hat{\Delta}_d^{-1}\left(\hat{d}_{d,L} r_L + \hat{d}_{d,S} r_S + \hat{d}_{d,E} r_E - \hat{d}_{d,D} r_D - \hat{d}_{d,F} r_F\right)$, where $\hat{d}_{d,L} \equiv (1-\rho)\upsilon_d \psi_d (1-\Gamma)$; $\hat{d}_{d,S} \equiv (1-\rho)(\omega_d + c_d)(1-\Gamma)$; $\hat{d}_{d,E} \equiv (1-\rho)\upsilon_d(\omega_d + c_d)\Gamma(1-\Gamma)$; $\hat{d}_{d,F} \equiv (1-\rho)\left(\omega_d + c_d + \sigma_d \Gamma^2\right)$; and $\hat{d}_{d,D} \equiv (1-\Gamma)^2(\omega_d + c_d)\upsilon_d$ $+\left[(\omega_d + c_d)\psi_d + (\omega_d + c_d + \psi_d)\sigma_d \Gamma^2\right]$	$D_d^{NM} = \tilde{\Delta}_d^{-1}\left(\tilde{d}_{d,L} r_L + \tilde{d}_{d,S} r_S + \tilde{d}_{d,E} r_E - \tilde{d}_{d,D} r_D - \tilde{d}_{d,F} r_F\right)$, where $\tilde{d}_{d,L} \equiv (1-\rho)\upsilon_d \psi_d (1-\Gamma)(1-\delta_d)$; $\tilde{d}_{d,S} \equiv (1-\rho)\omega_d (1-\Gamma)$; $\tilde{d}_{d,E} \equiv (1-\rho)\upsilon_d \omega_d \Gamma(1-\Gamma)$; $\tilde{d}_{d,F} \equiv (1-\rho)\left(\omega_d + \sigma_d \Gamma^2\right)$; and $\tilde{d}_{d,D} \equiv (1-\Gamma)^2 \omega_d \upsilon_d + \left[\omega_d \psi_d + (\omega_d + \psi_d)\sigma_d \Gamma^2\right]$
Net **Wholesale** **Borrowings**	$F_d^M = \hat{\Delta}_d^{-1}\left(\hat{f}_{d,L} r_L + \hat{f}_{d,S} r_S - \hat{f}_{d,E} r_E + \hat{f}_{d,D} r_D - \hat{f}_{d,F} r_F\right)$, where $\hat{f}_{d,L} \equiv \xi_d \psi_d (1-\Gamma)$; $\hat{f}_{d,S} \equiv \xi_d(\omega_d + c_d)(1-\Gamma)$; $\hat{f}_{d,E} \equiv \xi_d(\omega_d + c_d + \psi_d)\Gamma(1-\Gamma)$; $\hat{f}_{d,D} \equiv (1-\rho)\left[(\omega_d + c_d)\psi_d + (\omega_d + c_d + \psi_d)\sigma_d \Gamma^2\right]$; and $\hat{f}_{d,F} \equiv \xi_d \left\{\begin{matrix}\left[(\omega_d + c_d)\psi_d + (\omega_d + c_d + \psi_d)\sigma_d \Gamma^2\right](1-\rho) \\ -(1-\Gamma)^2\left(\omega_d + c_d + \psi_d + 2\sigma_d \Gamma^2\right)\end{matrix}\right\}$ $+(1-\rho)^2\left[(\omega_d + c_d)\psi_d + (\omega_d + c_d + \psi_d)\sigma_d \Gamma^2\right]$	$F_d^{NM} = \tilde{\Delta}_d^{-1}\left(\tilde{f}_{d,L} r_L + \tilde{f}_{d,S} r_S - \tilde{f}_{d,E} r_E + \tilde{f}_{d,D} r_D - \tilde{f}_{d,F} r_F\right)$, where $\tilde{f}_{d,L} \equiv \xi_d \psi_d (1-\Gamma)(1-\delta_d)$; $\tilde{f}_{d,S} \equiv \xi_d \omega_d (1-\Gamma)$; $\tilde{f}_{d,E} \equiv \xi_d(\omega_d + \psi_d)\Gamma(1-\Gamma)$; $\tilde{f}_{d,D} \equiv (1-\rho)\left[\omega_d \psi_d + (\omega_d + \psi_d)\sigma_d \Gamma^2\right]$; and $\tilde{f}_{d,F} \equiv \xi_d \left\{\begin{matrix}\left[\omega_d \psi_d + (\omega_d + \psi_d)\sigma_d \Gamma^2\right](1-\rho) \\ -(1-\Gamma)^2\left(\omega_d + \psi_d + 2\sigma_d \Gamma^2\right)\end{matrix}\right\}$ $+(1-\rho)^2\left[\omega_d \psi_d + (\omega_d + \psi_d)\sigma_d \Gamma^2\right]$

Table 2: Solutions for the Market Loan and Deposit Rates with a Leverage-Capital-Constrained Dominant Bank

	Solutions under Monitoring by Dominant Bank	Solutions without Monitoring by Dominant Bank
Loan Rate	$r_L^M = \dfrac{\Lambda\left(\hat{\Delta}_d r_F - \hat{f}_{d,E}\upsilon_d r_E - \hat{f}_{d,F}\upsilon_d r_F + \hat{f}_{d,S}\upsilon_d r_S\right)}{\hat{\Delta}_d - \upsilon_d\left(\hat{f}_{d.L}\Lambda + \hat{f}_{d,D}\Omega\right)}$	$r_L^{NM} = \dfrac{\Lambda\left(\tilde{\Delta}_d r_F - \tilde{f}_{d,E}\upsilon_d r_E - \tilde{f}_{d,F}\upsilon_d r_F + \tilde{f}_{d,S}\upsilon_d r_S\right)}{\tilde{\Delta}_d - \upsilon_d\left(\tilde{f}_{d.L}\Lambda + \tilde{f}_{d,D}\Omega\right)}$
Deposit Rate	$r_D^M = \dfrac{\Omega\left(\hat{\Delta}_d r_F - \hat{f}_{d,E}\upsilon_d r_E - \hat{f}_{d,F}\upsilon_d r_F + \hat{f}_{d,S}\upsilon_d r_S\right)}{\hat{\Delta}_d - \upsilon_d\left(\hat{f}_{d.L}\Lambda + \hat{f}_{d,D}\Omega\right)}$	$r_D^{NM} = \dfrac{\Omega\left(\tilde{\Delta}_d r_F - \tilde{f}_{d,E}\upsilon_d r_E - \tilde{f}_{d,F}\upsilon_d r_F + \tilde{f}_{d,S}\upsilon_d r_S\right)}{\tilde{\Delta}_d - \upsilon_d\left(\tilde{f}_{d.L}\Lambda + \tilde{f}_{d,D}\Omega\right)}$

Table 3: Optimal Balance Sheet Choices for Risk-Based-Capital-Ratio-Constrained Fringe Banks

	Solution under Monitoring ($\alpha = 0$ and $\beta = 1$)	**Solution without Monitoring ($\alpha = 1$ and $\beta = 0$)**
Loans	$L_f^M = \hat{\Delta}_f^{-1}\left(\hat{l}_{f,L}\left[r_L - \theta r_E\right] - \hat{l}_{f,S} r_S - \hat{l}_{f,D} r_D - \hat{l}_{f,F} r_F\right)$, where $\hat{l}_{f,L} \equiv \psi_f\left[(1-\rho)^2 \upsilon_f + \xi_f\right] + \upsilon_f \xi_f$; $\hat{l}_{f,S} \equiv (1-\theta)\upsilon_f \xi_f$; $\hat{l}_{f,D} \equiv (1-\theta)(1-\rho)\psi_f \upsilon_f$; $\hat{l}_{f,F} \equiv (1-\theta)\xi_f \psi_f$; and $\hat{\Delta}_f \equiv \left(\omega_f + c_f + \sigma_f \theta^2\right)\left\{\psi_f\left[\xi_f + \upsilon_f (1-\rho)^2\right] + \xi_f \upsilon_f\right\}$ $+ \psi_f \xi_f \upsilon_f (1-\theta)^2$	$L_f^{NM} = \tilde{\Delta}_f^{-1}\left(\tilde{l}_{f,L}\left[\left(1-\delta_f\right) r_L - \theta r_E\right] - \tilde{l}_{f,S} r_S - \tilde{l}_{f,D} r_D - \tilde{l}_{f,F} r_F\right)$, where $\tilde{l}_{f,L} \equiv \left\{\psi_f\left[(1-\rho)^2 \upsilon_f + \xi_f\right] + \upsilon_f \xi_f\right\}$; $\tilde{l}_{f,S} \equiv (1-\rho)\upsilon_f \xi_f$; $\tilde{l}_{f,D} \equiv (1-\theta)(1-\rho)\psi_f \upsilon_f$; $\tilde{l}_{f,F} \equiv (1-\theta)\xi_f \psi_f$; and $\tilde{\Delta}_f \equiv \left(\omega_f + \sigma_f \theta^2\right)\left\{\psi_f\left[\xi_f + \upsilon_f (1-\rho)^2\right] + \xi_f \upsilon_f\right\}$ $+ \psi_f \xi_f \upsilon_f (1-\theta)^2$
Securities	$S_f^M = \hat{\Delta}_f^{-1}\left(\hat{s}_{f,L}\left[r_L - \theta r_E\right] + \hat{s}_{f,S} r_S + \hat{s}_{f,D} r_D + \hat{s}_{f,F} r_F\right)$, where $\hat{s}_{f,L} \equiv (1-\theta)\xi_f \upsilon_f$; $\hat{s}_{f,S} \equiv \left(\omega_f + c_f + \sigma_f \theta^2\right)\left[\xi_f + \upsilon_f (1-\rho)^2\right] + (1-\theta)^2 \xi_f \upsilon_f$; $\hat{s}_{f,D} \equiv \left(\omega_f + c_f + \sigma_f \theta^2\right)\upsilon_f$; and $\hat{s}_{f,F} \equiv \left(\omega_f + c_f + \sigma_f \theta^2\right)\xi_f$	$S_f^{NM} = \tilde{\Delta}_f^{-1}\left(\tilde{s}_{f,L}\left[\left(1-\delta_f\right) r_L - \theta r_E\right] + \tilde{s}_{f,S} r_S + \tilde{s}_{f,D} r_D + \tilde{s}_{f,F} r_F\right)$, where $\tilde{s}_{f,L} \equiv (1-\theta)\xi_f \upsilon_f$; $\tilde{s}_{f,S} \equiv \left(\omega_f + \sigma_f \theta^2\right)\left[\xi_f + \upsilon_f (1-\rho)^2\right] + (1-\theta)^2 \xi_f \upsilon_f$; $\tilde{s}_{f,D} \equiv \left(\omega_f + \sigma_f \theta^2\right)\upsilon_f$; and $\tilde{s}_{f,F} \equiv \left(\omega_f + \sigma_f \theta^2\right)\xi_f$
Deposits	$D_f^M = \hat{\Delta}_f^{-1}\left(\hat{d}_{f,L}\left[r_L - \theta r_E\right] + \hat{d}_{f,S} r_S - \hat{d}_{f,D} r_D - \hat{d}_{f,F} r_F\right)$, where $\hat{d}_{f,L} \equiv (1-\rho)(1-\theta)\upsilon_f \psi_f$; $\hat{d}_{f,S} \equiv (1-\rho)\left(\omega_f + c_f + \sigma_f \theta^2\right)\upsilon_f$; $\hat{d}_{f,F} \equiv \psi_f (1-\rho)\left(\omega_f + c_f + \sigma_f \theta^2\right)$; and $\hat{d}_{f,D} \equiv \left(\omega_f + c_f + \sigma_f \theta^2\right)\left(\psi_f + \upsilon_f\right) + \psi_f \upsilon_f (1-\theta)^2$	$D_f^{NM} = \tilde{\Delta}_f^{-1}\left(\tilde{d}_{f,L}\left[\left(1-\delta_f\right) r_L - \theta r_E\right] + \tilde{d}_{f,S} r_S - \tilde{d}_{f,D} r_D - \tilde{d}_{f,F} r_F\right)$, where $\tilde{d}_{f,L} \equiv (1-\rho)(1-\theta)\upsilon_f \psi_f$; $\tilde{d}_{f,S} \equiv (1-\rho)\left(\omega_f + c_f\right)\upsilon_f$; $\tilde{d}_{f,F} \equiv \psi_f (1-\rho)\left(\omega_f + \sigma_f \theta^2\right)$; and $\tilde{d}_{f,D} \equiv \left(\omega_f + \sigma_f \theta^2\right)\left(\psi_f + \upsilon_f\right) + \psi_f \upsilon_f (1-\theta)^2$

Net Wholesale Borrowings	$F_f^M = \hat{\Delta}_f^{-1}\left(\hat{f}_{f,L}\left[r_L - \theta r_E\right] + \hat{f}_{f,S} r_S + \hat{f}_{f,D} r_D - \hat{f}_{f,F} r_F \right)$, where $\hat{f}_{f,L} \equiv \xi_f \psi_f (1-\theta)$; $\hat{f}_{f,S} \equiv \xi_f \left(\omega_f + c_f + \sigma_f \theta^2\right)$; $\hat{f}_{f,D} \equiv (1-\rho)\psi_f \left(\omega_f + c_f + \sigma_f \theta^2\right)$; and $\hat{f}_{f,F} \equiv \left(\omega_f + c_f + \sigma_f \theta^2\right)\left[\psi_f (1-\rho)^2 + \xi_f\right] + (1-\theta)^2 \psi_f \xi_f$	$F_f^{NM} = \tilde{\Delta}_f^{-1}\left(\tilde{f}_{f,L}\left[\left(1-\delta_f\right) r_L - \theta r_E\right] + \tilde{f}_{f,S} r_S + \tilde{f}_{f,D} r_D - \tilde{f}_{f,F} r_F \right)$, where $\tilde{f}_{f,L} \equiv \xi_f \psi_f (1-\theta)$; $\tilde{f}_{f,S} \equiv \xi_f \left(\omega_f + \sigma_f \theta^2\right)$; $\tilde{f}_{f,D} \equiv (1-\rho)\psi_f \left(\omega_f + \sigma_f \theta^2\right)$; and $\tilde{f}_{f,F} \equiv \left(\omega_f + \sigma_f \theta^2\right)\left[\psi_f (1-\rho)^2 + \xi_f\right] + (1-\theta)^2 \psi_f \xi_f$

Table 4: Baseline Parameters for Leverage-Based-Capital-Ratio-Constrained Dominant Bank and Risk-Based-Capital-Ratio-Constrained Fringe Banks

	υ_i	ψ_i	ξ_i	σ_i	ω_i	c_i	δ_i	η	ϕ	ε	ζ	Γ	θ	r_S	r_F	r_E
$i = d$	0.001	0.040	0.030	0.020	0.040	0.002	0.005	-1.5	—	2.0	—	0.06	—	0.030	0.030	0.050
$i = f$	0.002	0.045	0.035	0.025	0.045	0.003	0.006	—	2.0	—	-1.5	—	0.04	0.030	0.030	0.050

Table 5: Solutions for the Market Loan and Deposit Rates with a Risk-Based-Capital-Constrained Dominant Bank

	Solutions under Monitoring by Dominant Bank	Solutions without Monitoring by Dominant Bank
Loan Rate	$r_L^M = \dfrac{\Lambda\left(\hat{\Delta}_d' r_F - \hat{f}_{d,L}' \theta \upsilon_d r_E - \hat{f}_{d,F}' \upsilon_d r_F + \hat{f}_{d,S}' \upsilon_d r_S\right)}{\hat{\Delta}_d' - \upsilon_d\left(\hat{f}_{d,F}' \Lambda + \hat{f}_{d,D}' \Omega\right)}$	$r_L^{NM} = \dfrac{\Lambda\left(\tilde{\Delta}_d' r_F - \tilde{f}_{d,L}' \theta \upsilon_d r_E - \tilde{f}_{d,F}' \upsilon_d r_F + \tilde{f}_{d,S}' \upsilon_d r_S\right)}{\tilde{\Delta}_d' - \upsilon_d\left(\tilde{f}_{d,L}' \Lambda + \tilde{f}_{d,D}' \Omega\right)}$
Deposit Rate	$r_D^M = \dfrac{\Omega\left(\hat{\Delta}_d' r_F - \hat{f}_{d,L}' \theta \upsilon_d r_E - \hat{f}_{d,F}' \upsilon_d r_F + \hat{f}_S' \upsilon_d r_S\right)}{\hat{\Delta}_d' - \upsilon_d\left(\hat{f}_{d,L}' \Lambda + \hat{f}_{d,D}' \Omega\right)}$	$r_D^{NM} = \dfrac{\Omega\left(\tilde{\Delta}_d' r_F - \tilde{f}_{d,L}' \theta \upsilon_d r_E - \tilde{f}_{d,F}' \upsilon_d r_F + \tilde{f}_{d,S}' \upsilon_d r_S\right)}{\tilde{\Delta}_d - \upsilon_d\left(\tilde{f}_{d,L}' \Lambda + \tilde{f}_{d,D}' \Omega\right)}$
	where $\hat{f}_{d,L}' \equiv \xi_d \psi_d (1-\theta)$; $\hat{f}_{d,S}' \equiv \xi_d\left(\omega_d + c_d + \sigma_d \theta^2\right)$; $\hat{f}_{d,D}' \equiv (1-\rho)\psi_d\left(\omega_d + c_d + \sigma_d \theta^2\right)$; $\hat{f}_{d,F}' \equiv \left(\omega_d + c_d + \sigma_d \theta^2\right)\left[\psi_d (1-\rho)^2 + \xi_d\right] + (1-\theta)^2 \psi_d \xi_d$; and $\hat{\Delta}_d' \equiv \left(\omega_d + c_d + \sigma_d \theta^2\right)\left\{\psi_d\left[\xi_d + \upsilon_d (1-\rho)^2\right] + \xi_d \upsilon_d\right\} + \psi_d \xi_d \upsilon_d (1-\theta)^2$	where $\tilde{f}_{d,L}' \equiv \xi_d \psi_d (1-\theta)$; $\tilde{f}_{d,S}' \equiv \xi_d\left(\omega_d + \sigma_d \theta^2\right)$; $\tilde{f}_{d,D}' \equiv (1-\rho)\psi_d\left(\omega_d + \sigma_d \theta^2\right)$; $\tilde{f}_{d,F}' \equiv \left(\omega_d + \sigma_d \theta^2\right)\left[\psi_d (1-\rho)^2 + \xi_d\right] + (1-\theta)^2 \psi_d \xi_d$; and $\tilde{\Delta}_d' \equiv \left(\omega_d + \sigma_d \theta^2\right)\left\{\psi_d\left[\xi_d + \upsilon_d (1-\rho)^2\right] + \xi_d \upsilon_d\right\} + \psi_d \xi_d \upsilon_d (1-\theta)^2$

Table 6: Baseline Parameters for Risk-Based-Capital-Ratio-Constrained Dominant and Fringe Banks

	υ_i	ψ_i	ξ_i	σ_i	ω_i	c_i	δ_i	η	ϕ	ε	ζ	Γ	θ	r_S	r_F	r_E
$i = d$	0.001	0.040	0.030	0.020	0.040	0.002	0.005	-1.5	—	2.0	—	—	0.04	0.030	0.030	0.050
$i = f$	0.002	0.045	0.035	0.025	0.045	0.003	0.006	—	2.0	—	-1.5	—	0.04	0.030	0.030	0.050