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Bank Interest Margin and Default Risk under the Capped Schedule for Government Capital Injections in the Basel III Capital Adequacy Accord

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Abstract

The Basel III Capital Adequacy Accord (BCAA) will cap government capital injections as qualifying capital at 90% of the nominal amount of such capital outstanding, beginning in 2013, and the cap will decline by 10% during each subsequent year (Eubanks, 2010); this cap is called a capped ratio schedule of government capital instruments. We add to the literature on government capital injections by providing an option-based illustration of how the capped ratio schedule can influence bank interest margins and failure probability. We show that a declining capped ratio increases a bank's volume of lending at a reduced margin and further increases its default risk. The capped ratio schedule as such makes the bank less prudent and more prone to risk-taking, thereby adversely affecting the stability of the banking system. Our findings provide alternative explanations for criticisms of BCAA.

JEL classification: G21, G28
Keywords: Basel III, Government capital injection, Bank interest margin, Failure probability

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1 Introduction

As a result of the 2007- 2009 global financial crisis, many European and American banks are operating with capital injections from their governments. Without such government assistance, some banks would have failed during the crisis. Even with government capital injections, the list of distressed banks in the United States exceeds 800 (Eubanks, 2010). "At the Basel III meeting, the central bank's governors agreed … Government capital instruments that no longer qualify as non-common equity Tier 1 capital or Tier 2 capital will be phased-out over a 10-year period beginning on January 1, 2013. Beginning in 2013, the recognition of these instruments as qualifying capital will be capped at 90% of the minimal amount of such instruments outstanding, with the cap declining by 10% in each subsequent year" (Eubanks, 2010, p.8). Such a schedule is called the capped ratio schedule of government capital instruments in the Basel III Capital Adequacy Accord (BCAA). This agreement provides an obvious opportunity to reexamine bank liquidity management, which is related to bank failure probability.

The bank interest margin, is the spread between the interest rate that a the bank charges borrowers and the rate that it pays to depositors, and represents one of the principal elements of bank's net cash flows and earnings. Indeed, the bank interest margin is often used in the literature as a proxy for the efficiency of financial intermediation (Demirguc-Kunt and Huizinga, 2000, and Saunders and Schumacher, 2000). Prior research examines ex ante and ex post bank reactions to the introduction of government capital injections but fails to consider the impact of the capped ratio schedule of BCAA on the management of banks' interest margin and, further, on possible bankruptcy.[3] This omission is crucial because the capped ratio schedule is concerned with capital adequacy requirements. The purpose of this paper is to incorporate a capped schedule of BCAA into the option-based spread behavior model of a bank facing credit risk. The results of this paper show how bank capital, government capital injection, and capital regulation jointly determine the optimal bank interest margin and, further, the probability of bank failure. Numerical exercises are used to show that a decrease in the capped ratio decreases the interest margin, and increases the failure probability of the bank. Under the circumstances, we find that the impact on decreasing the bank's interest margin and increasing default risk from decreases in the capped ratio is less significant when the bank's capital level is higher, the government capital injection is higher, or the capital requirement is higher.

Basel III received harsh criticisms from the banking industry and regulators.[4] We add to the criticism arguing that a decreasing cap on government capital injections to qualify

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[3]See, for example, Hoshi and Kashyap (2010), Breitenfellner and Wagner (2010), and Bayazitova and Shivdasani (2012).

[4]For example, the Institute of International Finance warned in June 2010 that the Basel III proposal would require that these large banks raise $700 billion in common equity and issue $5.4 trillion in long term debt over next five years to meet the standards, which would cause a 3% decline in the U.S. GDP compared with what it would otherwise be in five years (Pruzin, 2010). JP Morgan Chase and Morgan Stanley argued that the Basel III proposal would significantly reduce the availability of credit to the U.S. economy (see http://www.bis.org/publ/bcbs165/jpmorganchase.pdf and http://www.bis.org/publ/bcbs165/morganstanley.pdf). Deutsche Bank's comment was that the timetable was too short to increase common equity because the prospects for future profits, the main source of common equity, are not good for the short (see http://www.bis.org/publ/bcbs165/deutschebankcap.pdf).

under the regulatory capital requirement of Basel III makes banks less prudent and more prone to risk-taking, thereby adversely affecting the stability of the banking system. The cap schedule in BCAA favors banks with a higher level of either private capital or government capital injections. This agreement is consistent with the demonstration of Eubanks (2010) that European banks are most critical of the proposal, arguing that Basel III favors U.S. banks because they have historically maintained a higher level of capital. The cap schedule as such also favors a lower level of risk-based system of capital standards. Moreover, Basel III may conflict with countries' own regulatory efforts. For example, the United States (the Dodd-Frank Act) and Germany (the Act for Strengthening of Financial Markets and Insurance Supervision) have pushed for tougher rules and are moving ahead with additional regulatory restrictions on their financial institutions (Eubanks, 2010). However, Basel III is not a treaty, but is a work in progress that is far from completion, and member countries may modify the agreement to suit their financial regulatory structures.

The remainder of this paper is organized as follows. We briefly review the related literature in Section 2. Section 3 applies the standard contingent claim to the determination of bank interest margin and bank failure probability under capital regulations. Section 4 derives the solution for the model and provides comparative static results through numerical analysis. Finally, Section 5 offers the conclusions.

2 Related Literature

Our theory of bank capital regulation is related to four strands of the recent literature. The first is the literature on bank behavior under capital regulation, in which VanHoose (2007), Kashyap et al. (2010), and Cosimano and Hakura (2011), for example, are major contributors. VanHoose (2011) reviews the theoretical literature on bank behavior under capital regulation, and finds that this literature produces highly mixed predictions with regard to the effects of capital regulation on banks' risk-taking behavior. Kashyap et al. (2010) examine the impact of higher capital requirements on bank lending rates and the volume of lending, and find that an increase in the capital to asset ratio increases lending spread under Basel III. Cosimano and Hakura (2011) study bank behavior in response to Basel III, and show that higher capital requirements, by raising banks' marginal cost of finding, lead to higher lending rates and slower credit growth. While we also study bank behavior in response to Basel III, our focus on bank spread behavior with government capital injections takes our analysis in a different direction.

The second strand is the modern government capital injection literature. Hoshi and Kashyap (2010) argue that the success of a government capital injection program depends critically on the willingness of troubled banks to participate in it. Breitenfellner and Wagner (2010) demonstrate that not suspending the market's bankruptcy mechanism by granting government capital injections is important. Bayazitova and Shivdasani (2012) show that strong banks opt out of government capital injection programs and these programs are provided to banks that pose systemic risk and face financial distress but have strong asset quality. The primary difference between our model and these papers is that we consider the impact of the capped into schedule of Basel III on the management of bank spread behavior and default risk with a rescue program of government capital injections.

The third strand is the literature on bank interest margin related to efficiency of financial intermediation. The pioneering study by Ho and Saunders (1981) has been the reference framework for many of the contemporary studies of determinants of bank interest margins. This study analyzes the determinants of bank interest margins and finds the interest margin depends on both the degree of market competition and the interest rate risk. The most recent extension of the Ho and Saunders (1981) model is studied by Maudo and de Guevara (2004) who find that market power, operating cost, risk aversion, interest rate and credit risk, implicit interest payments, and quality of management are positively related to bank interest margin. The results of Hawtrey and Liang (2008) are similar to those of Maudo and de Guevara (2004). Chang et al. (2011) show that bank interest margin is negatively related to bank profit when the optimal asset scale is relatively low. We abstract from the consideration of bank interest margin determinants and study bank spread behavior under Basel III.

The fourth strand of the literature to which our work is most directly related is that on conformity, particularly Cosimano and Hakura (2011). Other examples are Chu et al. (2007), Kashyap et al. (2010), and Pausch and Welzel (2012). The fundamental insight shared by these papers is that conformity is generated by a desire to distinguish oneself from the "type" with which one wishes not to be identified. This insight is an important aspect of bank interest margin as well, since decision makers agree with the margin determination to avoid inefficiency in the financial intermediation. What distinguishes our work from this literature is our focus on the commingling of the assessment of default risk in the bank's equity returns related to interest margin decisions with government capital injections and, in particular, the emphasis we put on the interaction between bank interest margins and conformity in the context of Basel III.

3 The Model

To model bank behavior, we apply a contingent claims approach to banking (Crouhy and Galai, 1991, and Bhattacharya et al., 1998), augmented by capital regulation of Basel III (Eubanks, 2010). More specifically, we consider a bank that makes decisions in a single period horizon with two dates, 0 and 1, $t \in [0,1]$. At $t = 0$, the bank has the following balance sheet:

$$L + B = D + K + (1-\alpha)K_g + \alpha K_g \qquad (1)$$

where $L > 0$ is the amount of loans, $B > 0$ is the amount of liquid assets, $D > 0$ is the quantity of deposits, $K > 0$ is the stock of the bank's equity capital, and $K_g > 0$ is the volume of equity capital injected by the government. By regulation, $(1-\alpha)K_g$ where $0 < \alpha < 1$ will be capped at $(1-\alpha)$ of the nominal amount of such outstanding government injection. Besides K, the only amount of government capital injection $(1-\alpha)K_g$ is included when the capital requirements is measured. Note that an increase in the capped ratio $(1-\alpha)$ is equivalent to a decrease in the discounted ratio α.

The bank enjoys market power in the loan market (Wong, 2011). L in Eq. (1) can be interpreted either as the total of homogeneous loans or as aggregates representing well-diversified portfolio of loans. The decision of loans is made via the setting of loan rate, $R_L > 0$, at $t = 0$. The bank faces a loan demand function $L(R_L)$ with

$\partial L/\partial R_L < 0$. Loans are risky because they are subject to non-performance. In addition to loans, the earning-asset portfolio of the bank includes liquid assets B held by the bank during the period horizon. These assets earn the security-market interest rate of $R > 0$.

The total assets to be financed at $t = 0$ are $L + B$. They are financed partly by D, which is insured by a government-funded deposit insurance scheme. The supply of deposits is perfectly elastic at the fixed deposit rate $R_D > 0$. The bank's shareholder contribute equity capital K at $t = 0$. A government capital injection program can stabilize the bank by providing a source of K_g at $t = 0$ when public market alternatives are unavailable during a financial crisis. Equity capital held by the bank at $t = 0$ is $K + K_g$. Through regulation, the equity capital of the bank has to satisfy only the following capital adequacy requirement: $K + (1-\alpha)K_g \geq qD$, where q is the capital-to-deposits ratio (VanHoose, 2007). The required ratio q is assumed to be an increasing function of L held by the bank at $t = 0$, $\partial q/\partial L > 0$ (Zarruk and Madura, 1992). When the capital requirement is binding, the bank's balance-sheet constraint becomes $L + B = [K + (1-\alpha)K_g](1/q + 1) + \alpha K_g$.[5] Note that the amount of αK_g no longer qualifies as equity capital for capital regulation based on the argument of Basel III.

The broader contingent claims approach has found a natural application in bank regulation. Our approach is to calculate default risk measures using Merton's (1974) model, which is very similar to the model used by Vassalou and Xing (2004). The equity of a banking firm is viewed as a call option on a bank's assets. Specifically, equity holders are residual claimants on a bank's loan repayments after all other net-obligation payments have been met. The strike price of the call is the book value of a bank's net-obligation payments. When the value of a bank's loan repayments is less than the strike price, the value of equity is zero. The market value of the bank's underlying assets follows a geometric Brownian motion (GBM) of the form:

$$dV = \mu V dt + \sigma V dW \tag{2}$$

where $V = (1 + R_L)L$ is the bank's loan repayments, with an instantaneous drift μ, and an instantaneous volatility σ. A standard Wiener process is W. We denote by Z the book value of the net-obligation payments at $t = 0$ that has maturity equal to $t = 1$. The net-obligation payments specified as the difference between the deposit payments and the liquid-asset repayments are given by:

$$Z = (1 + R_D)D - (1 + R)B =$$

$$= \frac{(1 + R_D)[K + (1-\alpha)K_g]}{q} - (1 + R)[(K + (1-\alpha)K_g)(\frac{1}{q} + 1) + \alpha K_g - L] \tag{3}$$

where Z plays the role of the strike price of the call option since the market value of equity can be thought of as a call option on V with time to expiration equal to $t = 1$.

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[5]The capital requirement constraint will be binding as loan as R is sufficiently higher than R_D (Wong, 1997).

The market value of equity S will then be given by the Black and Scholes (1973) formula for call options:

$$S = VN(d_1) - Ze^{-\delta} N(d_2) \tag{4}$$

where

$$d_1 = \frac{1}{\sigma}(\ln\frac{V}{Z} + \delta + \frac{\sigma^2}{2}), \quad d_2 = d_1 - \sigma$$

and where $\delta = R - R_D$ is the risk-free spread rate, and $N(\cdot)$ is the cumulative density function of the standard normal distribution.

Valuation Eq. (4) implies a risk-neutral failure probability over the interval from $t \in [0,1]$. The failure probability is the probability that V will be less than Z in our model.[6] In other words:

$$P_{def,\,t=0} = Prob(V_{t=1} \le Z_{t=0} \,|\, V_{t=0}) = Prob(\ln V_{t=1} \le \ln Z_{t=0} \,|\, V_{t=0})$$

Since V follows the GBM of Eq. (4), V is given by:

$$\ln V_{t=1} = \ln V_{t=0} + (\mu - \frac{\sigma^2}{2}) + \sigma\varepsilon_{t=1}$$

where

$\varepsilon_{t=1} = W(t=1) - W(t=0)$, and $\varepsilon_{t=1} \sim N(0,1)$

Therefore, we can restate the failure probability as follows:

$$P_{def,\,t=0} = Prob(\ln V_{t=0} - \ln Z_{t=0} + (\mu - \frac{\sigma^2}{2}) + \sigma\varepsilon_{t=1} \le 0)$$

$$= Prob(-\frac{1}{\sigma}(\ln\frac{V_{t=0}}{Z_{t=0}} + \mu - \frac{\sigma^2}{2}) \ge \varepsilon_{t=1})$$

We can then define the distance to default d_3 as follows:

$$d_3 = \frac{1}{\sigma}(\ln\frac{V}{Z} + \mu - \frac{\sigma^2}{2})$$

Failure or default occurs when the ratio of V to Z is less than 1, or its log is negative. d_3 tells us by how many standard deviations the log of this ratio needs to deviate from its mean for default to occur. In this case, the failure probability is given by:

$$P_{def} = N(-d_3) \tag{5}$$

4 Solutions and Comparative Static Analysis

With all of the assumptions in place, we are now ready to solve for the bank's choice of

[6]Vassalou and Xing (2004) develop a model of a firm with exactly this structure.

R_L. Partially differentiating Eq. (4) with respect to R_L, the first-order condition is given by:

$$\frac{\partial S}{\partial R_L}=\frac{\partial V}{\partial R_L}N(d_1)+V\frac{\partial N(d_1)}{\partial d_1}\frac{\partial d_1}{\partial R_L}-\frac{\partial Z}{\partial R_L}e^{-\delta}N(d_2)-Ze^{-\delta}\frac{\partial N(d_2)}{\partial d_2}\frac{\partial d_2}{\partial R_L}=0 \qquad (6)$$

where

$$V\frac{\partial N(d_1)}{\partial d_1}\frac{\partial d_1}{\partial R_L}=Ze^{-\delta}\frac{\partial N(d_2)}{\partial d_2}\frac{\partial d_2}{\partial R_L}$$

$$\frac{\partial V}{\partial R_L}=L(1+R_L)\frac{\partial L}{\partial R_L}<0, \text{ and}$$

$$\frac{\partial Z}{\partial R_L}=[\frac{(R-R_D)(K+(1-\alpha)K_g)q'}{q^2}+(1+R)]\frac{\partial L}{\partial R_L}<0$$

We require that the second-order condition $\partial^2 S/\partial R_L^2<0$ be satisfied. The first term on the right-hand side of Eq. (6) can be interpreted as the risk-adjusted value of marginal loan repayments, while the third term can be interpreted as the risk-adjusted value of marginal net- obligation payments. Inspection of the equilibrium of Eq. (6) reveals that a necessary condition for an interior solution of the optimal loan rate (and thus the optimal bank interest margin since R_D is not a choice variable of the bank) is that both marginal values are equal for equity maximization since the value of the second term equals the value of the last term. We further substitute the optimal R_L to obtain the failure probability of the bank in Eq. (5) staying on the optimization.

Next, we consider next the effect of decreases in a capped ratio (equivalently increases in a discounted ratio of α) of government capital injection on a bank's interest margin. Implicit differentiation of Eq. (6) with respect to α yields:

$$\frac{\partial R_L}{\partial \alpha}=-\frac{\partial^2 S}{\partial R_L\partial\alpha}/\frac{\partial^2 S}{\partial R_L^2} \qquad (7)$$

where

$$\frac{\partial^2 S}{\partial R_L\partial\alpha}=[\frac{\partial^2 V}{\partial R_L\partial\alpha}N(d_1)-\frac{\partial^2 Z}{\partial R_L\partial\alpha}e^{-\delta}N(d_2)]+(\frac{\partial V}{\partial R_L}-\frac{V}{Ze^{-\delta}}\frac{\partial Z}{\partial R_L})\frac{\partial N(d_1)}{\partial d_1}\frac{\partial d_1}{\partial\alpha}$$

$$\frac{\partial^2 V}{\partial R_L\partial\alpha}=0,\quad \frac{\partial^2 Z}{\partial R_L\partial\alpha}=\frac{(R-R_D)K_g q'}{q^2}\frac{\partial L}{\partial R_L}>0$$

$$\frac{\partial d_1}{\partial\alpha}=-\frac{1}{\sigma Z}\frac{\partial Z}{\partial\alpha},\quad \frac{\partial Z}{\partial\alpha}=\frac{(R-R_D)K_g}{q}>0$$

The sign of $\partial R_L/\partial\alpha$ in Eq. (7) is governed by its numerator since the second-order condition $\partial^2 S/\partial R_L\partial\alpha$ can be interpreted as the mean effect on $\partial S/\partial R_L$ from a change in α, while the second term can be interpreted as the variance on risk effect. The mean effect is positive in sign, but the sign of the variance effect is indeterminate. The sign of $\partial R_L / \partial \alpha$ remains unknown.

A related question is to consider the effect of decreases in a capped ratio on the bank's failure probability. Differentiation of Eq. (5) evaluated at the optimal R_L with respect to α yields:

$$\frac{dP_{def}}{d\alpha} = \frac{\partial P_{def}}{\partial \alpha} + \frac{\partial P_{def}}{\partial R_L}\frac{\partial R_L}{\partial \alpha} \tag{8}$$

where

$$\frac{\partial P_{def}}{\partial \alpha} = -\frac{\partial N(d_3)}{\partial d_3}\frac{\partial d_3}{\partial \alpha}, \quad \frac{\partial d_3}{\partial \alpha} = \frac{\partial d_1}{\partial \alpha} < 0$$

$$\frac{\partial P_{def}}{\partial R_L} = -\frac{\partial N(d_3)}{\partial d_3}\frac{\partial d_3}{\partial R_L}, \text{ and } \frac{\partial d_3}{\partial R_L} = \frac{1}{\sigma}\left(\frac{1}{V}\frac{\partial V}{\partial R_L} - \frac{1}{Z}\frac{\partial Z}{\partial R_L}\right)$$

The first term on the right-hand side of Eq. (8) can be identified as the direct effect, while the second term can be identified as the indirect effect through the optimal loan rate choices. The direct effect is positive in sign, but the sign of the indirect effect is indeterminate. The sign of the total effect remains unknown.

The added complexity of option-based valuation does not always lead to clear-cut results of Eqs (7) and (8). However, we can certainly speak of tendencies for reasonable parameter levels that approximately correspond to the results of Eqs (7) and (8). We start from a set of assumptions, unless otherwise indicated, on $R = 3.50\%$, $R_D = 2.50\%$, $\sigma = 0.10$, and $\mu = 0.01$. Let ($R_L\%, L$) change from (4.50, 300) to (5.75, 275) because $\partial L / \partial R_L < 0$, and let α fluctuate between 0.1 and 0.9 based on the capped ratio schedule of BCAA. Note that (i) the specification of $R > R_D$ explains a possibility of capital requirement constraint that will be binding for Eq. (1) (Wong, 1997), (ii) $R_L > R$ indicates fund reserves as liquidity and asset substitutability in the earning-asset loan portfolio (Kashyap et al., 2002), and (iii) $R_L > R_D$ is used to be a proxy for the efficiency of financial intermediation (Saunders and Schumacher, 2000). The parameters used in the numerical analysis can be given intuition roughly approaching a real state of a hypothetical bank. Now, we calculate S, $\partial R_L / \partial \alpha$, P_{def}, and $dP_{def} / d\alpha$, which are consistent with Eqs (4), (7), (5), and (8), respectively, given the condition of Eq. (6).

Table 1: Values of S and $\partial R_L / \partial \alpha$ at $K = 20$, $K_g = 20$, $q = 8\%$,and various levels of $(1-\alpha)$

	$(R_L\%, L)$					
$(1-\alpha)$	(4.50, 300)	(4.75, 295)	(5.00, 290)	(5.25, 285)	(5.50, 280)	(5.75, 275)
	S					
0.9	52.1835	52.7622	53.3225	53.8638	54.3855	54.8873
0.7	51.7085	52.2850	52.8433	53.3827	53.9027	54.4029
0.5	51.2343	51.8086	52.3647	52.9022	53.4205	53.9190
0.3	50.7609	51.3329	51.8869	52.4224	52.9389	53.4358

0.1	50.2885	50.8581	51.4099	51.9434	52.4579	52.9531
	$\partial^2 S / \partial R_L \partial \alpha$					
0.9~0.7		-0.0022	-0.0020	-0.0019	-0.0017	-0.0016
0.7~0.5		-0.0022	-0.0022	-0.0019	-0.0017	-0.0017
0.5~0.3		-0.0023	-0.0021	-0.0020	-0.0018	-0.0016
0.3~0.1		-0.0024	-0.0022	-0.0020	-0.0020	-0.0017
	$\partial^2 S / \partial R_L^2$					
0.9	-	-0.0184	-0.0190	-0.0196	-0.0199	-
0.7	-	-0.0182	-0.0189	-0.0194	-0.0198	-
0.5	-	-0.0182	-0.0186	-0.0192	-0.0198	-
0.3	-	-0.0180	-0.0185	-0.0190	-0.0196	-
0.1	-	-0.0178	-0.0183	-0.0190	-0.0193	-
	$\partial R_L / \partial \alpha$					
0.9~0.7	-	-0.1099	-0.1005	-0.0876	-0.0808	-
0.7~0.5	-	-0.1209	-0.1022	-0.0885	-0.0859	-
0.5~0.3	-	-0.1167	-0.1081	-0.0947	-0.0816	-
0.3~0.1	-	-0.1236	-0.1093	-0.1053	-0.0881	-

Note: Unless stated otherwise, parameter values are $R = 3.50\%$, $R_D = 2.50\%$, $\sigma = 0.10$ and $\mu = 0.01$. According to the capped ratio of BCAA, the cap declines 10% in each subsequent year. The parameter levels of $(1-\alpha)$ in this table should include 0.9, 0.8, 0.7, 0.6, …, 0.1. For simplicity, this column ignores the levels of 0.8, 0.6, …, 0.2. Adding this complexity does not affect any of the qualitative results.

First, we consider a case of a bank capital level of $K = 20$ with an amount of government capital injection of $K_g = 20$ under a capital requirement of $q = 8\%$. We have the results of $S > 0$, $\partial^2 S / \partial R_L \partial \alpha < 0$, $\partial^2 S / \partial R_L^2 < 0$, and $\partial R_L / \partial \alpha < 0$ observed from Table 1. Note that $\partial^2 S / \partial R_L^2 < 0$ captures the validness of the second-order condition of equity return maximization of Eq. (4). $\partial R_L / \partial \alpha < 0$ indicates that, as the capped ratio decreases (and thus the discounted ratio increases), the bank's interest margin is decreased. Intuitively, as the bank is forced to decrease the capped ratio, it must now provide a return to a larger equity capital base. One way the bank may attempt to augment its total returns is by shifting its investments to its loan portfolio and away from the interbank market. If loan demand is relatively rate-elastic, a larger loan portfolio is possible at a reduced margin. As mentioned earlier, a decrease in the capped ratio is recognized as a higher capital requirement. Our finding shows that higher capital requirements lower loan volume and increase the interest rate on loans (and thus the bank interest margin), which is consistent with the findings of Kashyap et al. (2010), Cosimano and Hakura (2011), and Pausch and Welzel (2012).

Table 2: Values of P_{def} and $dP_{def}/d\alpha$ at $K=20$, $K_g=20$, $q=8\%$, and various levels of $(1-\alpha)$

	$(R_L\%, L)$					
$(1-\alpha)$	(4.50, 300)	(4.75, 295)	(5.00, 290)	(5.25, 285)	(5.50, 280)	(5.75, 275)
	$P_{def}\%$					
0.9	3.9608	3.5242	3.1205	2.7487	2.4079	2.0969
0.7	4.1250	3.6766	3.2613	2.8782	2.5263	2.2047
0.5	4.2944	3.8341	3.4070	3.0124	2.6494	2.3169
0.3	4.4691	3.9967	3.5578	3.1515	2.7772	2.4337
0.1	4.6490	4.1645	3.7136	3.2956	2.9098	2.5551
	$\partial P_{def}/\partial\alpha$: direct effect					
0.9~0.7	0.1642	0.1524	0.1408	0.1295	0.1184	0.1078
0.7~0.5	0.1694	0.1575	0.1457	0.1342	0.1231	0.1122
0.5~0.3	0.1747	0.1626	0.1508	0.1391	0.1278	0.1168
0.3~0.1	0.1799	0.1678	0.1558	0.1441	0.1326	0.1214
	$(\partial P_{def}/\partial R_L)(\partial R_L/\partial\alpha)$: indirect effect					
0.9~0.7	-	0.0456	0.0385	0.0308	0.0260	-
0.7~0.5	-	0.0516	0.0403	0.0321	0.0285	-
0.5~0.3	-	0.0512	0.0439	0.0355	0.0280	-
0.3~0.1	-	0.0557	0.0457	0.0406	0.0312	-
	$dP_{def}/d\alpha$: total effect					
0.9~0.7	-	0.1864	0.1680	0.1492	0.1338	-
0.7~0.5	-	0.1973	0.1745	0.1552	0.1407	-
0.5~0.3	-	0.2020	0.1830	0.1633	0.1448	-
0.3~0.1	-	0.2115	0.1898	0.1732	0.1526	-

Note: Unless stated otherwise, parameter values are $R=3.50\%$, $R_D=2.50\%$, $\sigma=0.10$ and $\mu=0.01$.

In Table 2, we observe the following results: $P_{def}>0$, $\partial P_{def}/\partial\alpha>0$, $(\partial P_{def}/\partial R_L)(\partial R_L/\partial\alpha)>0$, and $dP_{def}/d\alpha>0$. The direct effect is captured by the change in P_{def} given an increase in α, holding the bank interest margin constant. It is unambiguously positive because a decrease in the capped ratio makes loans riskier to grant at a relative low capital buffer level, thus, increasing the bank's default probability, ceteris paribus. The indirect effect arises because an increase in α increases the loan portfolio held by the bank at a reduced margin, and thus increases the bank's default probability. Because the indirect effect reinforces the direct effect to give an overall positive response of P_{def} to an increase in α, we conclude that a decrease in the capped ratio increases the bank's default probability. When the additional capital from a government assistance program is not totally counted in Tier 1 capital or Tier 2 capital, the new regulation as such makes the bank less prudent and more prone to asset risk-taking and thus increasing the bank's default probability, and adversely affecting the stability of the banking system. An immediate application of the result is to evaluate the capped ratio schedule of BCAA for future lending under capital regulations. A decrease in the capped ratio can be recognized as an implicit withdrawal of government capital injection. Under the schedule, banks with the government assistance need an additional capital to meet the regulatory capital standards. For example, the French Bankers

Association assessment is that the adjustment to Basel III is unworkable because it would result in a Tier 1 capital shortage of between $2.7 trillion and $4.7 trillion for Eurozone countries alone.[7] Thus, our criticism provides an alternative explanation for this empirical assessment.

Interestingly, by controlling for a bank's capital level from private markets, a government capital injection level and a capital requirement based on the benchmark case above, allows further examination of the effect of the BCAA capped ratio schedule on lending strategy and the probability of bankruptcy.

Table 3: Values of $\partial R_L / \partial \alpha$ at various levels of K, K_g, q, and $(1-\alpha)$

	$(R_L\%, L)$					
$(1-\alpha)$	(4.50, 300)	(4.75, 295)	(5.00, 290)	(5.25, 285)	(5.50, 280)	(5.75, 275)
	$(K=20,\ K_g=20,\ q=8\%)$					
0.9~0.7	-	-0.1099	-0.1005	-0.0876	-0.0808	-
0.7~0.5	-	-0.1209	-0.1022	-0.0885	-0.0859	-
0.5~0.3	-	-0.1167	-0.1081	-0.0947	-0.0816	-
0.3~0.1	-	-0.1236	-0.1093	-0.1053	-0.0881	-
	$(K=25,\ K_g=20,\ q=8\%)$					
0.9~0.7	-	-0.0697	-0.0585	-0.0566	-0.0423	-
0.7~0.5	-	-0.0704	-0.0683	-0.0526	-0.0561	-
0.5~0.3	-	-0.0804	-0.0690	-0.0580	-0.0516	-
0.3~0.1	-	-0.0765	-0.0693	-0.0631	-0.0521	-
	$(K=20,\ K_g=25,\ q=8\%)$					
0.9~0.7	-	-0.0850	-0.0825	-0.0667	-0.0610	-
0.7~0.5	-	-0.0955	-0.0833	-0.0721	-0.0660	-
0.5~0.3	-	-0.1010	-0.0846	-0.0773	-0.0667	-
0.3~0.1	-	-0.0979	-0.0945	-0.0784	-0.0718	-
	$(K=20,\ K_g=20,\ q=10\%)$					
0.9~0.7	-	-0.0950	-0.0806	-0.0785	-0.0663	-
0.7~0.5	-	-0.1006	-0.0870	-0.0789	-0.0670	-
0.5~0.3	-	-0.0960	-0.0924	-0.0798	-0.0773	-
0.3~0.1	-	-0.1073	-0.0934	-0.0806	-0.0773	-
	$(K=25,\ K_g=20,\ q=10\%)$					
0.9~0.7	-	-0.0606	-0.0542	-0.0481	-0.0425	-
0.7~0.5	-	-0.0657	-0.0547	-0.0483	-0.0427	-
0.5~0.3	-	-0.0612	-0.0597	-0.0488	-0.0474	-
0.3~0.1	-	-0.0670	-0.0600	-0.0539	-0.0431	-
	$(K=20,\ K_g=25,\ q=10\%)$					
0.9~0.7	-	-0.0808	-0.0693	-0.0531	-0.0563	-
0.7~0.5	-	-0.0765	-0.0743	-0.0634	-0.0521	-
0.5~0.3	-	-0.0872	-0.0704	-0.0683	-0.0574	-
0.3~0.1	-	-0.0876	-0.0761	-0.0686	-0.0580	-
Note: Unless stated otherwise, parameter values are $R=3.50\%$, $R_D=2.50\%$, $\sigma=0.10$ and $\mu=0.01$.						

In Table 3, we present the values of $\partial R_L / \partial \alpha$ in Eq. (7) at various levels of K, K_g, q, and $(1-\alpha)$. The calculation of these results follows an exact process as in the benchmark case of $K=20$, $K_g=20$, and $q=8\%$ in Table 1, again presented in the

[7]See the assessment at http://www.asf-france.com.

first panel of Table 3. We observe the consistent results of $\partial R_L / \partial \alpha < 0$. The interpretation of these results follows a similar argument as in the benchmark case of Table 1. Furthermore, we show that the negative impact on the bank's interest margin from an increase in the capped ratio is more significant when $K = 20$ in the benchmark than when $K = 25$ in the second panel, and than when $K_g = 25$ in the third panel. Capital structure as such makes the bank less prudent and more prone to loan risk-taking when the bank provides a return to a lower capital base, thereby adversely affecting the stability of the banking system. We also find that this negative impact effect is also more significant when $q = 8\%$ in the benchmark case than when $q = 10\%$ in the last three panels. Capital regulation as such makes the bank more prone to loan risk-taking.

Table 4: Values of $dP_{def} / d\alpha$ at various levels of K, K_g, q, and $(1-\alpha)$

	$(R_L\%, L)$					
$(1-\alpha)$	(4.50, 300)	(4.75, 295)	(5.00, 290)	(5.25, 285)	(5.50, 280)	(5.75, 275)
	($K = 20$, $K_g = 20$, $q = 8\%$)					
0.9~0.7	-	0.1864	0.1680	0.1492	0.1338	-
0.7~0.5	-	0.1973	0.1745	0.1552	0.1407	-
0.5~0.3	-	0.2020	0.1830	0.1633	0.1448	-
0.3~0.1	-	0.2115	0.1898	0.1732	0.1526	-
	($K = 25$, $K_g = 20$, $q = 8\%$)					
0.9~0.7	-	0.1117	0.0976	0.0867	0.0741	-
0.7~0.5	-	0.1162	0.1043	0.0897	0.0806	-
0.5~0.3	-	0.1239	0.1088	0.0949	0.0832	-
0.3~0.1	-	0.1274	0.1132	0.1003	0.0871	-
	($K = 20$, $K_g = 25$, $q = 8\%$)					
0.9~0.7	-	0.1405	0.1257	0.1087	0.0954	-
0.7~0.5	-	0.1507	0.1325	0.1162	0.1022	-
0.5~0.3	-	0.1595	0.1397	0.1238	0.1081	-
0.3~0.1	-	0.1662	0.1497	0.1306	0.1154	-
	($K = 20$, $K_g = 20$, $q = 10\%$)					
0.9~0.7	-	0.1611	0.1430	0.1305	0.1153	-
0.7~0.5	-	0.1677	0.1494	0.1346	0.1190	-
0.5~0.3	-	0.1700	0.1558	0.1387	0.1263	-
0.3~0.1	-	0.1795	0.1605	0.1430	0.1301	-
	($K = 25$, $K_g = 20$, $q = 10\%$)					
0.9~0.7	-	0.0982	0.0868	0.0765	0.0669	-
0.7~0.5	-	0.1027	0.0898	0.0791	0.0694	-
0.5~0.3	-	0.1044	0.0942	0.0819	0.0730	-
0.3~0.1	-	0.1094	0.0972	0.0861	0.0745	-
	($K = 20$, $K_g = 25$, $q = 10\%$)					
0.9~0.7	-	0.1253	0.1100	0.0947	0.0853	-
0.7~0.5	-	0.1286	0.1158	0.1013	0.0880	-
0.5~0.3	-	0.1370	0.1193	0.1071	0.0933	-
0.3~0.1	-	0.1423	0.1257	0.1115	0.0975	-

Note: Unless stated otherwise, parameter values are $R = 3.50\%$, $R_D = 2.50\%$, $\sigma = 0.10$ and $\mu = 0.01$.

In Table 4, we present the values of $dP_{def}/d\alpha$ in Eq. (8) at various levels of K, K_g, q, and $(1-\alpha)$ evaluated at the optimal loan rate. The calculation of these results follows an exact process as in the benchmark case in Table 2. We find the consistent results of $dP_{def}/d\alpha > 0$: as the capped ratio increases, the default risk in the bank's equity returns is increased. Specifically, this positive impact is larger when $K = 20$ in the benchmark case than when $K = 25$ or $K_g = 25$ in the second and third panel, respectively. This positive impact effect is also larger when $q = 8\%$ in the benchmark case than when $q = 10\%$ in the cases of the last three panels. Capital structure or capital regulation as such increases the bank's default risk.

The intuition observed from Tables 3 – 4 is very straightforward. When the capital from a government assistance program is not totally counted in the regulatory capital requirement, an increase in this discount increases the capital required to meet the regulatory standard. Eubanks (2010) argued that Basel III favors U.S. banks but not European banks because U.S. banks historically maintained a higher level of capital and more easily met the increased capital requirement. Our findings are consistent with this empirical argument. Next, our results add to the observation for the BCAA capped ratio schedule that the proposal to not totally count government capital injections in the regulatory capital requirement favors a bank with a high-level of government capital injection at a high cost to taxpayers (Eubanks, 2010). Furthermore, the purpose of Basel III is to remedy the regulatory and liquidity failures that resulted during the 2007-2008 global financial crisis. In particular, Basel III proposes the capped ratio schedule for government capital injections. However, the United States and other countries are pursuing similar remedies, for example, capital requirements increased in the Dodd-Frank Act in the United States, and Germany's Act for Strengthening of Financial Markets and Insurance Supervision increases capital (Eubanks, 2010). Our finding is consistent with Eubanks (2010), who showed that the BCAA cap schedule may conflict with countries' own regulations.

5 Conclusion

At the Basel III meeting, the central bank's governors agreed with the capped ratio schedule that called for, beginning in 2013, capping government capital instruments as qualifying capital at 90% of the nominal amount of such instruments outstanding, with the cap declining by 10% in each subsequent year. In this paper, we examine the optimal bank interest margin for banks regulated by the BCAA's capped ratio schedule. We show that the presence of capped ratio that decreases each year increases the loan portfolio held by the bank at a reduced margin, and further increases the default probability in equity returns of the bank. Such capital regulation makes banks less prudent and more prone to risk-taking, thereby adversely affecting the stability of the banking system. This schedule may conflict with the efforts of different countries through their plans to increase capital requirements on banks, such as the Dodd- Frank Act of the United States. However, Basel III is not a treaty. Countries may modify the agreement to meet their financial regulatory structures to ensure efficient financial intermediation.

Issues not addressed in this study include bank capitalization and lending behavior with procyclicality after the introduction of the BCAA's capped ratio schedule. Particularly, in economic contractions when lending tends to be riskier, the Basel framework recommends higher levels of capital, which may slow or possibly prevent banks from lending. Such concerns are beyond the scope of this paper and are not addressed here. However, this paper demonstrates the important role played by government capital instruments in the capped ratio schedule of Basel III in affecting the determination of bank interest margin and the probability of bank failure.

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