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Optimal bank interest margins under capital regulation in a call-option utility framework

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ABSTRACT

This paper examines the optimal bank interest margin under capital regulation when the bank's preference admits an additive call-option representation including both the like of higher equity return and the dislike of higher equity risk. In the call-option utility maximization, an increase in the capital requirement results in an increased amount of loans held by a bank at a reduced margin when loan quality is in distress. We also show that the impact on the bank interest margin from an increase in the capital requirement which ignores the dislike, that we call such behavior call-option equity maximization, leads to significant underestimation. Our results cast doubt on the effectiveness of capital regulation to exert a risk-reducing and return-increasing effect on the bank in particular where loan quality becomes worse, thereby adversely affecting the stability of the banking system.

1. Introduction

The first Basel Accord was adopted in 1988 and capital regulation under the Basel came into effect in 1992. Basel I is credited with providing stability to the international banking system, both through defining consistent safety and soundness standards and by promoting better coordination among regulatory authorities in participating countries (Eubanks, 2010). Basel II in 2004 was developed because the methods used to calculate the requirements in Basel I was not sufficiently sensitive in measuring risk exposures (Rochet, 2004), and the regulatory capital needed in the increasingly complex and competitive banking system could not be determined accurately and consistently under the Basel I framework (Boyd and De Nicolò, 2005). Basel III in 2010 remedied the regulatory capital and liquidity failures because Basel II was never fully implemented in particular after subprime mortgage problems led to American financial crisis of 2007 (Eubanks, 2010).

If stability-oriented capital regulation policies are effective, more stringently prudent capital regulations should, in principle, lead to more cautious bank operations. There is a large stream of literature that analyzes the impact on bank behavior from risk-sensitive capital requirements. For example, Peura and Keppo (2006) study bank optimal capital choice as a trade-off between the opportunity cost of equity capital, and the loss of franchise value following a regulatory minimum capital violation. Zhu (2007) introduces an equilibrium model in which banks maximize expected discounted dividend payments but are constrained in their lending behavior by minimum capital requirements. Hakenes and Schnabel (2011) show that capital regulation may destabilize the banking sector through its effect on banking competition. However, it is well recognized that the banking literature is sharply divided into the effects of capital requirements on bank behavior, the risks faced by individual institutions, and the banking system as a whole (VanHoose, 2007). Some academic work indicates that capital requirements unambiguously contribute to various possible measures of bank stability. In contrast, other work argues that capital requirements make banks riskier institutions than they would be in the absence of such requirements.[1] This paper aims to directly focus on the reasons for the literature's conflicting arguments about the effects of capital regulations on bank behavior. In particular, when the banking industry experienced a renewed focus on retail banking in a financial crisis, this trend actually attributed to the profitability and stability of retail activities.[2]

Our primary emphasis is the selection of the bank's optimal interest margin, that is the spread between the rate of interest the bank charges borrowers and that it pays to depositors. The bank interest margin is a principal element of bank net cash flows and earnings in retail banking, and it is often used in the literature as a proxy for the efficiency of financial intermediation under capital regulations (see,

[1] For reviews of empirical evidence and of broader implications of capital regulation for economic stability, see Wang (2005), VanHoose (2006, 2007), and Episcopos (2008).

[2] Hirtle and Stiroh (2007) demonstrate that U.S. banks, particularly the largest, have dramatically expanded their retail banking operations over the last few years. Hasan et al. (2012) also examine returns to retail banking using data from across 27 European markets over the period 2000–07.

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for example, Hyun and Rhee, 2011; VanHoose, 2007). Using a firm-theoretical approach, Wong (1997), and Broll and Wong (2010) examine how the bank interest margin is determined when the bank's preference admits the standard von Neumann–Morgenstern expected utility representation. Given the case of a separation of management from ownership, the bank's managers may have incentives to make decisions that maximize their own expected utility (Jensen and Meckling, 1976). This approach, however, omits two aspects of financial intermediation. First, the capital regulation has become a major issue in the banking industry after loan quality problems led to the American financial crisis of 2007 (Hyun and Rhee, 2011). The bank's preference characterized by a utility function without considering disutility from significant losses on loans might be not applicable to a distressed situation of a financial crisis. Second, the broader contingent claims approach has found an application in the bank capital regulation (see, for example, Episcopos, 2008; Tsai and Hung, 2013). The bank's utility function defined in terms of the book value of bank equity rather than the market value of bank equity might be limited. The omission of terms involving the market value of underlying assets will have significant consequences especially when the likelihood of asset variability is substantial in a financial crisis.

The purpose of this paper is to incorporate the preference of the equity return utility and the equity risk disutility into a call-option-based firm-theoretical model for a bank under the capital regulation. To the end, we apply Hermalin (2005) to characterize the bank's preference by a utility function that additionally includes disutility from the equity risk. We call such a behavior as the call-option utility–disutility preference. The principal advantage of this approach is the explicit treatments of the equity return and the risk that can be motivated based on an implicit fundamental concept of the modern portfolio theory in the spirit of von Neumann–Morgenstern preference.[3] To the best of our knowledge, this is the first attempt to introduce the disutility from the equity risk explicitly in the literature on the market-based estimation of the bank objective under the capital regulation.

Furthermore, loan quality or loan variability problems have plagued banks. Concerns about the bank loan quality and bank failures have prompted regulators to adopt a risk-based system of capital standards. Capital-to-deposits ratios designed by regulators are actually increasing functions of the amount of risky assets held by the bank (VanHoose, 2007).[4] We show that an increase in the capital-to-deposits ratio decreases the risky loans held by the bank at an increased margin when the bank has low loan variability but increases the loan holding at a reduced margin when the bank has high loan variability under the call-option utility maximization. In a call-option equity maximization where the dislike is ignored, we show that the negative impact on the margin by an increase in the capital requirement leads to significant underestimation.

One immediate application of this research is to evaluate the plethora of optimization problems with various loan quality levels proposed as alternatives for future lending decisions under the capital regulation. The stringent capital requirement as such makes the bank more prudent and less prone to loan risk when the objective is the call-based utility maximization with low loan variability, thereby contributing to the stability of the banking system. However, the capital regulation should be imposed on the bank asset quality in deterioration. In contrast, the capital regulation as such enables the bank to be much more prone to loan risk, specifically under the utility maximization at a relatively low loan quality as well as under the equity maximization. And, this can adversely affect the stability of the banking system. Our main contribution is to control for bank loan variability levels, which enables us to better understand the impact of capital requirements on lending strategies. As a result, we cast a doubt on the effectiveness of the capital requirement to exert a risk-reducing and return-increasing effect on the bank, in particular, with loan deterioration, thereby adversely affecting bank profitability and banking system stability. Our doubt is consistent with some survey findings of VanHoose (2007) that the capital requirement alone will not necessarily contribute to safety-and-soundness improvements.

The paper proceeds as follows. Section 2 lays out the option-based utility model of a bank. Section 3 characterizes the optimal bank interest margin and further develops the comparative static results of the capital regulation. Section 4 outlines numerical exercises to analyze the effectiveness of the capital regulation. And, final concluding remarks will follow.

2. The model

The model is designed to capture the following characteristics of a bank: (i) the bank's manager likes higher bank equity returns, but dislikes higher bank equity risks; (ii) the bank defaults when it fails to service its debt obligations; and (iii) bank equity returns and risks are increasing functions of the default probability of a bank. Note that (iii) implies that the model will have to incorporate three related valuations: bank equity returns, equity risks, and default probabilities. As we discuss below, the three valuation frameworks can be based on a contingent-claim analysis in the spirit of Merton (1974), Ronn and Verma (1986), and Vassalou and Xing (2004), respectively.

Consider the bank's manager who makes decisions in a single period horizon with two dates, $t \in [0,\ 1]$.[5] At $t=0$, the bank has the following balance sheet:

$$L + B = D + K \tag{1}$$

where $L>0$ is the amount of loans, $B>0$ is the quantity of liquid assets, $D>0$ is the amount of deposits, and $K>0$ is the stock of equity capital. The bank's loans belong to a single homogeneous class of fixed-rate claims that mature and are paid off at $t=1$. The demand for loans is governed by a downward-sloping demand function, $L(R_L)$, where $R_L>0$. And, the loan rate is chosen by the bank (Tsai and Hung, 2013).[6] Loans are risky subject to non-performance. Liquid assets earn the security-market interest rate of $R>0$. The total assets $L+B$ are financed partly by deposits. It is assumed that the total assets are traded continuously;[7] however, the bank's deposits can withdraw their money only at a discrete time interval. Money deposited, say in time deposits, is committed for one period. The supply of deposits is perfectly elastic at a constant market deposit rate, $R_D>0$. Equity capital held by the bank at $t=0$ is tied by the capital regulation which is a fixed proportion q of the bank's deposits, $K \geq qD$. The required capital-to-deposits ratio q is assumed to be an increasing function of L, and $\partial q/\partial L = q' > 0$. And, this forces the bank's capital position to

[3] Basically, the portfolio theory assumes that investor's preference depends on the first two moments (mean and variance) of the random liquidation value of its portfolio.

[4] The academic literature on the bank behavior under the capital regulation utilizes lots of diverse theoretical bank modeling approaches and contemplates the capital regulation in terms of required capital levels, the simple leverage (capital–asset) ratio, the required capital as percentages of deposits, the required capital as a percentage of loans or subsets of loans, and, most clearly in relation to weighted averages of loans or assets (Eubanks, 2010; VanHoose, 2007). Below, this paper is limited to the approach of the required capital as percentages of deposits. Naturally, from the point of view of the capital-to-deposits ratio requirement, the result will be a change in the composition of the optimal asset portfolio with the balance sheet constraint.

[5] We are a bit informal here and use the two terms of "the bank's manager" and "the bank" synonymously.

[6] Results derived from this paper are expected not to extend to the case where loan market structure faced by the bank is perfectly competitive (see, Baltensperger, 1980).

[7] This assumption, while not necessary, facilitates some of the deviations and numerical examples.