Optimal lending under strategic acquisition and capital regulation:
an option-based optimization

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Abstract

This paper explores the determinants of the acquirer bank’s optimal loan rate based on a firm-theoretical option-pricing model under the maximum net gain from strategic acquisition. The model demonstrates how the nature of the loan (substitutes/complements), loan rate strategies (strategic substitutes/strategic complements) and regulation conditions jointly determine the acquirer bank’s optimal loan rate. We find that the acquirer bank’s loan rate are negatively related to the proportion of the combined banks owned by the acquirer bank’s shareholders and also negatively related to the capital regulation under the nature of the loan complements and the loan-rate-setting complement strategy. Our findings provide an alternative explanation for the acquirer bank’s strategies for operating and competing in the lending market concerning bank acquisition behavior.

Keywords: Black-Scholes valuation, optimal loan rate, strategic acquisition, capital regulation.

1. Introduction

Expected increases in market share for loans, deposits and other services and geographic diversification to reduce risk by serving markets with different economic profiles and income flows caused by the liberalization of the banking and finance systems have contributed to a surge in mergers and acquisitions in the last two decades. Further adding momentum to this movement, the regulatory authorities have been plagued in many Asian countries who often use mergers and acquisitions since the financial crisis in mind-1997. Merging two banks to create a stronger one is seen as a panacea, thus resulting in more mergers and acquisitions.

In the recent and interesting paper on “Option pricing on stocks in mergers and acquisitions”, Subramanian (2004) had adopted the portfolio-theoretic theory as the analytical apparatus and developed an arbitrage-free and complete model in continuous time to price options on the stocks of firms involved in merger and acquisition deals. The principal advantage of this approach is the explicit treatment of uncertainty which has long played a prominent role in discussions of firm behavior, in particular, banking-firm behavior. This approach, however, omits a key aspect of firm behavior, which is assumed that the market structure faced by firms is perfectly competitive.

We are a bit informal here and use “mergers and acquisitions” and “acquisitions” synonymously.
Kahn, Pennacchi and Sopranzetti (2005) pointed out that a growing literature examines market structures and merger and acquisition activities of the banking firms, for example, Berger, Rosen and Udell (2001), Sapienza (2002), and Rhodes-Kropf and Viswanathan (2004). Thus, Subramanian’s model (2004) is not applicable to lending markets since such markets are virtually always highly concentrated where banking firms set rates and face random lending level.2 Surprisingly, little is known about the effect of acquisitions where bank lending markets are imperfectly competitive. This paper seeks to address this gap in the literature by investigating how the nature of loan products, loan rate-setting strategies and capital regulation jointly determine the acquirer bank’s optimal loan rates with the option-based maximum gain from strategic acquisition decisions.

The number of mergers and acquisitions in recent years has allowed for the study of their effects on public shareholders and stock market reactions to the mergers and acquisitions (Neely (1987), and Rhodes-Kropf and Viswanathan (2004)). This merger-event approach focuses on stock prices around the time of the merger and acquisition announcement.3 Mergers and acquisitions become interesting where financial markets are imperfectly competitive. As a consequence, Neely’s argument about increasing mergers and acquisitions further allows the study of their effects on equity holders on the basis of the structure-conduct-performance characteristics of the firm-theoretic approach.

There are at least two different but equally important areas where a thorough understanding of the importance of mergers and acquisitions is essential. First, finance theory suggests that acquisitions, like other strategic option-based investment decision, should occur because they are positive net-present-value projects that increase the market value of the acquirer firm’s shareholders. The acquisition investment decisions rely largely on understanding the return-risk characteristics of the portfolio-theoretic approach. Second, firm theory claims that the operating syner-

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2 For the characteristics of imperfect loan markets in which financial intermediaries exist, see Pringle (1973). Empirical studies by Slovin and Sushka (1983) and Hancock (1986) support the use of rate-setting behavior in loan markets. This assumption of imperfect loan markets is also employed by Zarruk and Madura (1992) to theoretically examine the relationships among capital regulation, deposit insurance and optimal bank interest margin.

3 Malatesta (1983), Neely (1987) and Cornett and De (1991) utilized merger and acquisition events to analyze the wealth effect of the activities.
gies in a strategic acquisition, like other profit-maximizing decisions, occur because the acquirer firm can raise product prices after buying up the competition, therefore, gaining monopolistic power through mergers and acquisitions. The profit-maximizing acquisition decisions thus depend on an understanding of the structure-conduct-performance characteristics of the firm-theoretic approach.

As mentioned previously, the advantage of the portfolio-theoretic approach is the explicit treatment of uncertainly, the uncertainly treated as stock return volatility is of considerable importance to investors since return volatility expectations influence the acquirer bank’s portfolio choice and are critical factors in pricing options. Thus, an understanding of the volatility expectations and their relationship to the expected returns in banking acquisition is critical. One of the objectives of this paper includes using the option-based Black-Scholes (1973) formula, often employed to compute an implied variance from call option market prices, to provide such an understanding. Although uncertainly is well captured in the portfolio-theoretic approach, this approach omits a key bank behavior in acquisitions. It is assumed that asset and deposit markets are perfectly competitive so that rate taking (or quantity-setting) is the relevant behavioral mode in both markets. However, bank acquisitions, especially large bank acquisitions, are made only when competition is imperfect. In addition, the premiums paid in bank acquisitions are critical to a cost-benefit framework for analyzing bank acquisitions as noted by Sinkey (1992, pp. 846–847). According to Rhoades (1987), the premiums paid in bank acquisitions can be treated as an indicator of the firm or market characteristics that are attractive to the managers of the acquirer firms. Furthermore, the liberalization of banking systems also deregulates banking markets and activities, including the lending and absorption of funds. This paper also utilizes the firm-theoretic approach in order to capture the deregulation effect on acquisitions.

Bank acquisitions have significantly changed their asset and capital positions. Asset quality problems arising from the increase in acquisition activity has plagued banks. To force bank capital positions to reflect asset portfolio risks, the regulatory authority can utilize a risk-based system of

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capital standards. Changes in the regulatory parameters are expected to affect bank acquisitions as well as bank profits and risks.

In light of previous work, the purpose of this paper is to develop a model of a strategic bank acquisition that integrates the risk consideration of the portfolio-theoretic approach with the market conditions and capital regulations of the firm-theoretic approach. More specifically, the Black-Scholes formula is extended to integrate the portfolio-theoretic volatilities with the firm-theoretic rate-setting modes in an analysis of the acquirer bank’s strategy for maximizing the net gain from the acquisition. The comparative-static results of the model are examined to determine the influence of give-and-take premiums in the acquisition and capital regulation of an acquirer bank’s loan rate-setting decisions. We find that the acquirer bank’s loan-rate setting is negatively related to the premiums paid in the bank acquisition and the capital-to-deposits ratio, considering some specific firm and market characteristics as well as uncertainty. Our findings provide an alternative explanation for the acquirer bank’s strategies for operating and competing in the loan market concerning bank acquisition.

This paper is organized as follows. Section 2 sets up a cost-benefit framework for analyzing bank acquisition. Section 3 develops the basic structure of the model. Section 4 provides a derivation solution of the model and the comparative static analysis. The final section contains concluding remarks.

2. Cost-benefit framework

A cost-benefit framework for analyzing a strategic bank acquisition under uncertainty is constructed. The benefit of a bank acquisition can be stated as the difference between the synergistic present value of the combined banks, $S_{1&2}$ and the sum of both the acquirer and acquired bank’s present values, $S$ and $S^*$, respectively, if they operate separately. $S_{1&2} - S - S^* > 0$ makes this acquisition potentially worthwhile. Moreover, the cost of the acquisition can be expressed as the difference between the amount paid for the acquired bank, $P^*$ and its value as a separate bank. Accordingly, the premium paid for the acquired bank is $P^* - S^*$. The premium is believed to be the maximum by the acquired bank whereas this cost is expected to be the minimum by the acquirer bank. Thus, the premium is determined using a give-and-take negotiation
process between the acquirer bank and the acquired bank. Combining the benefit and the cost of the bank acquisition, a potentially beneficial acquisition investment decision is beneficial if the benefit is expected to exceed the cost, that is,

\[
(S_{1&2} - S - S^*) - (P^* - S^*)
\]

\[
\begin{cases} 
> 0 & \text{if strategic acquisition comes into operation,} \\
\leq 0 & \text{if strategic acquisition does not.}
\end{cases}
\]

The difference in the above equation is treated as the net gain from the strategic acquisition activity to the acquirer bank. The focal point of the cost-benefit analysis emphasizes determining the values and premiums of the bank acquisition since the net gain can also be expressed as

\[
S_{1&2} - P^* > 0
\]

by rearranging terms in the equation above. Therefore, the net gain from the acquisition will be positive if the present value of the combined banks is greater than the present value of the acquirer bank plus the price paid for the acquired bank. Note that price of the acquired bank is defined as its present value plus the purchase premium.

Determining the amount paid for the acquired bank, \(P^*\), is a critical issue in acquisition analysis. As noted by Sinkey, the payment formula used when the acquisition is financed using common stock can be expressed as \(\delta\) multiplied by the value of the combined banks, \(P^* = \delta S_{1&2}\), where \(\delta\) is the proportion of the combined banks owned by the acquired bank’s shareholders, \(0 < \delta < 1\). Thus, the net gain to the acquirer bank

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\(5\)The total market value of the combined banks may not increase after the merger. The merger will increase the wealth of the acquirer bank’s shareholders if the merger price is sufficiently low (it may even have to be negative, pointed out by Delhaise (1998, p. 44)), even if the total market value of the combined banks decreases after the merger. Conversely, the merger will decrease the wealth of the acquirer bank’s shareholders if the merger price is sufficiently high, even if the total market value of the combined banks increases after the merger. In the Asian financial turmoil of 1997, Delhaise’s (1998, p. 44) contention is that “… some banks for sale are not exactly offering the kind of return on equity foreign buyers would expect. This problem can be reflected in the acquisition price,… many banks would have to carry a negative sale price to attract a buyer.” In addition, from the viewpoint of the acquirer bank’s acquisition investment decision, its manager is most likely motivated to increase the wealth of his shareholders. Thus, this paper makes a possible assumption in specifying a positive net-gain formula for acquisition pricing.

\(6\)Estimating the premium paid for the bank to be acquired depends on how the merger is financed (e.g., cash, common sock, or some combination of the two). In a cash transaction, the premium payment to the acquire bank’s shareholders is independent of whether or not the merger activity conduct is a synergistic one since their return does not rely on the operation of the combined banks. Calculating the premium payment for the stock financing approach is a completely different matter and can be computed using two different
can be simplified and given by the difference between the present value of the combined banks owned by the acquirer bank’s shareholders and the present value of the acquirer bank operating individually, \( \theta S_{1,2} - S > 0 \), where \( \theta = 1 - \delta \).

To manipulate the cost-benefit framework in this paper, several factors must be determined: \( \delta, \theta \), the value of the combined banks and the value of the bank making the acquisition. These determinations are critical to the model shown in the following section.

3. The model

Consider a single-period model of a bank acquisition under loan repayment uncertainty. An acquirer bank with no legal reserve requirement holds two types of earnings assets: open market securities, \( B \) and loans \( L \). The acquirer bank, in general, is generally a rate-taker in the open market so that the interest rate on open market securities, \( R \), is given. As mentioned earlier, mergers and acquisitions take priority when competition is imperfect. As such, the acquirer bank is assumed to be a rate-setter that faces a downward-sloping demand curve for its loans and chooses the loan rate \( R_L \), to maximize profits. This assumption implies the acquirer bank exercises some monopoly power in its lending activities. Correspondingly, the acquired bank holds two types of earning assets: market securities, \( B^* \) and loans, \( L^* \), and chooses the loan rate, \( R_{L^*} \), to maximize profits.

To capture the rate-setting conjectural variations, if both the acquirer bank and the acquired bank operate separately, the demands for loans faced by both banks are respectively

\[
L = L(R_L, R^*_{L^*}), \quad \frac{\partial L}{\partial R_L} < 0 \tag{1a}
\]

\[
L^* = L^*(R_L, R^*_{L^*}), \quad \frac{\partial L^*}{\partial R_{L^*}} < 0 \tag{1b}
\]

where, \( L \) and \( L^* \) are substitutes when \( \partial L/\partial R^*_{L^*} > 0 (\partial L^* / \partial R_L > 0) \) and complements when \( \partial L/\partial R^*_{L^*} < 0 (\partial L^* / \partial R_L < 0) \).

methods. Rhoades (1987) determined three independent variables in his model: acquired firm characteristics, market characteristics and acquiring firm characteristics. Darrell (1973) proposed three techniques to estimate premiums: the book-value approach, the market-to-book premiums and the income-to-income premiums. Thus use of these techniques alters both \( \delta \) and premium values computed.
Rhoades analyzed the premiums paid in bank acquisitions using the assumption that the premiums paid signaled market characteristics. Furthermore, regulatory capital requirements are an important factor in the firm characteristics of Rhoades’ investigation. Given such factors, a risk-based system of capital standards is utilized since an acquisition involves capital expendability. This system is designed to force a bank’s capital positions to reflect its asset portfolio risks; the essence of the portfolio-theoretic approach.

At the start of a single-period model, the acquirer bank raises \( D \) in deposits and \( E \) in equity capital. \( E \) is restricted through regulations to a fixed proportion of the acquirer bank’s deposits, \( E \geq qD \). Following Zarruk and Madura (1992), the required capital-to-deposits ratio, \( q \), is assumed to be an increasing function of the loans held by the acquirer bank at the beginning point of the period, \( dq/dL > 0 \). We assume that the acquired bank faces the same required capital-to-deposits ratio regulation as the acquirer bank. Thus, \( E^* \geq qD^* \) and \( dq/dL^* > 0 \).

When the capital constraint is binding, both the acquirer and the acquired banks’ liquidity constraints are, respectively,

\[
L + B = E + D = E \left( 1 + \frac{1}{q} \right),
\]

\[
L^* + B^* = E^* + D^* = E^* \left( 1 + \frac{1}{q} \right).
\]

The initial loanable funds are invested in a two-asset portfolio composed of default-free securities maturing at the end of the period and risky lending assets with an unspecified maturity greater than one period. During the period, the value of the acquirer bank’s risky lending assets is:

\[
V(R_L, R^*_L) = \begin{cases} 
(1 + R_L)L(R_L, R^*_L) & \text{without loan losses,} \\
< (1 + R_L)L(R_L, R^*_L) & \text{with loan losses.}
\end{cases}
\]

The total promised security repayments to the acquirer bank at the end of the period are certain because the open market securities are treated as risk-default assets in the model. The value of the acquirer bank’s earning-asset portfolio, if operating separately, is then:

\[
A = V(R_L, R^*_L) + (1 + R) \left[ E \left( 1 + \frac{1}{q} \right) - L(R_L, R^*_L) \right].
\]

\(^7\)For an analysis of the effects of capital requirements in terms of capital-to-deposits ratio, see Mullins and Pyle (1994).
The depositors are offered a rate $R_D$ on their deposits. The total promised payment to the depositors at the end of the period is $(1 + R_D)E/q$. The limited liability effect of debt (deposits) financing creates a possible part of the residual claimants for debtholders (deposits). Depositors will receive all of the promised payment only if that possibility does not occur at the end of the period. However, all of the acquirer bank’s earning assets (even if insufficient to cover all debts) are owned by the depositors under bankruptcy. The value of the deposits at the end of the period are given using:

$$j = \begin{cases} 
(1 + R_D)\frac{E}{q} & \text{if solvency } (A > J), \\
A & \text{if insolvency } (A \leq J).
\end{cases} \quad (5)$$

The value of the acquirer bank’s equity at the end of the period is defined as the residual value of the acquirer bank after meeting all of its debts, represented by

$$S = \begin{cases} 
A - J & \text{if solvency } (A > J) \\
0 & \text{if insolvency } (A \leq J)
\end{cases} \quad (6)$$

Santomero (1984) noted that the choice of an appropriate goal in modeling bank optimization problem remains a controversial issue. As reported by Subramanian (2004, p. 795), there were 279 merger and acquisition deals announced during the year of 2001, of which 177 deals involved firms where either the target on the acquirer had traded options and 67 deals involved firms where the target and the acquirer had traded options. With the growing number of stocks that have listed options and the accompanying growth in volume of trading in options, pricing options on merging banking firms in the Black-Scholes (1973) framework becomes crucial.

In our model, by applying Crouchy and Galai (1991), and Mullins and Pyle (1994), it may be assumed that the dollar amount invested by the shareholders is equal to the call option they effectively purchase from the bondholders. We then analyze the acquisition decision using a single period model, which relies on Black and Scholes’ option valuation. The stochastic variable, $S$, is the market value of the acquirer bank’s assets at the time of an audit. For the sake of parsimony, the cost of an audit is not considered in this model. The market value of the equity $S$ in equation (6) can be treated as the Black-Scholes value of the call option written bellow.
The first part is the risk-adjusted present value of the acquirer bank’s assets (loans) with repayment uncertainty expressed using the standard deviation of the return. The second part is referred to the risk adjusted present value of the acquirer bank’s net obligations to its initial depositors above and beyond its default-free securities. This exercise is expressed as a spread rate defined as the difference between the open market rate and the promised deposit rate, \( \mu = R - R_D \). Under these assumptions, the acquirer bank’s equity market value for equation (6) can be described as:

\[
S = V(R_L, R_L^*) N(d_1) - \left\{ (1 + R_D) \frac{E}{q} - (1 + R) \left[ E \left( 1 + \frac{1}{q} \right) - L(R_L, R_L^*) \right] \right\} e^{-\mu} N(d_2) \tag{7}
\]

where,

\[
d_1 = \frac{1}{\hat{\sigma}} \left\{ \ln \left( \frac{(1 + R_D)E}{q} - (1 + R) \left[ E \left( 1 + \frac{1}{q} \right) - L \right] \right) + \mu + \frac{1}{2} \hat{\sigma}^2 \right\},
\]

\[
d_2 = d_1 - \hat{\sigma},
\]

\[
\hat{\sigma}^2 = \sigma_v^2 + \sigma_1^2 - 2\rho_{v,1}\sigma_v\sigma_1.
\]

In equation (7), \( N(d_1) \) and \( N(d_2) \) are the cumulative standard normal distributions. \( N(d_1) \) is the risk adjustment factor of the acquirer bank’s risky assets (loans) while \( N(d_2) \) is the risk adjustment factor of the acquirer bank’s net obligations (the difference between deposit liability payment and open market securities repayment). \( \hat{\sigma}^2 \) is the variance with \( \sigma_v \) and \( \sigma_1 \) which are the instantaneous standard deviations for the rates of return on the risky and default-free assets, respectively. \( \rho_{v,1} \) is the instantaneous correlation coefficient.

The presence of economics of scope and/or cost reduction may create an incentive for specialty banks to merge and become multiple-plant-multiple-product banks. To determine the value of the combined banks in the cost-benefit acquisition framework, we assume that the combined banks are an imperfectly competitive financial intermediary that “produces” two distinct yet interrelated loans (\( L \) and \( L' \)) in two separate “plants” (the acquirer bank and the acquired bank) and ‘sells’ them in a market. The combined banks’ two distinct yet interrelated loans have a complementary nature if, for example, a bank has an
advantage in retail financial services specialization and the other has 
an advantage in wholesale financial services. They have the nature of 
substitutes if, for example, both banks have similar advantages in financial 
services specialization and are primarily based on the belief that possible 
gains can be acquired through management of these advantages. Under 
the circumstances, the combined banks are treated as an imperfectly 
competitive multiple-plant-multiple-product financial intermediary with 
a multiple-loan demand function.

\[ M = M(L(R_L, R^*_L), L^*(R_L, R^*_L)), \quad \frac{\partial M}{\partial L} > 0, \quad \frac{\partial M}{\partial L^*} > 0. \quad (8) \]

The combined banks have \( D + D^* \) in deposits and \( E + E^* \) in equity 
capital. Performing the acquisition activity under the capital requirement 
regulation, \( E + E^* \) is assumed to be tied by the same fixed proportion \( q \) of 
\( D + D^* \) as that of \( D \) or \( D^* \) if operated separately. Thus, when the capital 
constraint is binding, the combined banks’ liquidity constraint is:

\[ M + (B + B^*) = (E + E^*) + (D + D^*) = (E + E^*) \left(1 + \frac{1}{q}\right). \quad (9) \]

The combined loanable funds are also invested in default-free securi-
ties maturing at the end of the period and in risky lending assets with 
an unspecified maturity greater than one period. At any time, the value of 
the combined banks’ risky assets is:

\[
W(L(R_L, R^*_L), L^*(R_L, R^*_L))
\begin{cases}
= (1 + R_L)L(R_L, R^*_L) \\
+ (1 + R^*_L)L^*(R_L, R^*_L) & \text{without loan losses,} \\
< (1 + R_L)L(R_L, R^*_L) \\
+ (1 + R^*_L)L^*(R_L, R^*_L) & \text{with loan losses.} 
\end{cases}
\quad (10)
\]

The value of the combined banks’ earning-asset portfolios composed 
of the loan repayments and promised security repayments at the end of 
the period is:

\[ H = W(L(R_L, R^*_L), (R_L, R^*_L)) \\
+ (1 + R) \left[(E + E^*) \left(1 + \frac{1}{q}\right) - M(L(R_L, R^*_L), L^*(R_L, R^*_L))\right]. \quad (11) \]

The value of the deposit liabilities at the end of the period is:

\[ K = \begin{cases}
\frac{(1 + R_D)(E + E^*)}{q} & \text{if solvency } (H > K), \\
H & \text{if insolvency } (H \leq K). 
\end{cases} \quad (12) \]
The value of the combined banks' equity at the end of the period is:

\[ S_{1&2} = \begin{cases} H - K & \text{if solvency (} H > K \text{)}, \\ 0 & \text{if insolvency (} H \leq K \text{)}. \end{cases} \] (13)

Computing the acquisition analysis, the combined bank's Black-Scholes call option value can be expressed as:

\[ S_{1&2} = W(L(R_L, R_L^*), L^*(R_L, R_L^*))N(a_1) - \left(\frac{(1 + R_D)(E + E^*)}{q} - (1 + R)\right) \times \left[(E + E^*)\left(1 + \frac{1}{q}\right) - M(L(R_L, R_L^*), L^*(R_L, R_L^*))\right] e^{-\mu N(a_2)} \] (14)

where,

\[ a_1 = \frac{1}{\sigma_M} \left\{ \ln \frac{W}{(1 + R_D)(E + E^*)q} - (1 + R) \left[(E + E^*)\left(1 + \frac{1}{q}\right) - M\right] \right\} + \mu + \frac{1}{2} \sigma_M^2, \]

\[ a_2 = a_1 - \sigma_M, \]

\[ \sigma_M^2 = \sigma_v^2 + \sigma_1^2 - 2 \rho \sigma_v \sigma_1. \]

In equation (14), \( N(a_1) \) and \( N(a_2) \), the cumulative standard normal distributions, are the risk adjustment factors of the present value of the combined banks' assets and net obligations, respectively. \( \sigma_M^2 \) is the variance with \( \sigma_v \) and \( \sigma_1 \), i.e., the instantaneous standard deviation of the rates of return on the risky and default-free assets, respectively. \( \rho \sigma_v \sigma_1 \) is the instantaneous correlation coefficient.

The net gain from the strategic acquisition investment to the acquirer bank can be calculated with equations (7) and (14) by utilizing the cost-benefit framework discussed in the previous section. The acquirer bank should merge with the acquired bank if the benefit exceeds the cost, that is,

\[ I = \theta S_{1&2} - S > 0. \] (15)

Thus, the acquirer bank's net gain from the acquisition under the stock transaction is positive if the present value of the combined banks owned by the acquirer bank's shareholders is greater than the present value of the acquirer bank operating individually. This limitation provides an alternative insight for the acquirer bank's acquisition decision.8

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8According to Rose's (1987) empirical study, the acquired bank is significantly more profitable compared to the acquirer bank in returns earned for stockholders. Rose's findings may discourage the acquirer bank from conducting the acquisition. Thus, it is not surprising
4. Equilibrium and comparative statics

Acquisition is an investment issue and loan-rate setting is a competition issue of the banking industry. In managing value, a bank needs a strategy for competing in the market and a strategy for corporate control. The objective of this paper is managing value with the loan-rate-setting acquirer bank to maximize the net gain from acquisition. Specifically, the acquirer bank’s objective in the strategic acquisition is to set $R_L$ as well as $R^*_L$ in order to maximize the net gain. Partially differentiating equation (15) with respect to $R_L$ and $R^*_L$, the first-order conditions are:

$$\frac{\partial I}{\partial R_L} = \theta \left[ \left( \frac{\partial W}{\partial L} \frac{\partial L}{\partial R_L} + \frac{\partial W}{\partial L^*} \frac{\partial L^*}{\partial R_L} \right) N(a_1) \right] - \left( 1 + R \right) \left( \frac{\partial M}{\partial L} \frac{\partial L}{\partial R_L} + \frac{\partial M}{\partial L^*} \frac{\partial L^*}{\partial R_L} \right) e^{-\mu} N(a_2)$$

$$\left[ \left( \frac{\partial V}{\partial R_L} + \frac{\partial V}{\partial R^*_L} \right) N(d_1) \right] - \left( 1 + R \right) \left( \frac{\partial L}{\partial R_L} + \frac{\partial L}{\partial R^*_L} \right) e^{-\mu} N(d_2) = 0 \quad (16a)$$

$$\frac{\partial I}{\partial R^*_L} = \theta \left[ \left( \frac{\partial W}{\partial L} \frac{\partial L}{\partial R^*_L} + \frac{\partial W}{\partial L^*} \frac{\partial L^*}{\partial R^*_L} \right) N(a_1) \right] - \left( 1 + R \right) \left( \frac{\partial M}{\partial L} \frac{\partial L}{\partial R^*_L} + \frac{\partial M}{\partial L^*} \frac{\partial L^*}{\partial R^*_L} \right) e^{-\mu} N(a_2)$$

$$\left[ \left( \frac{\partial V}{\partial R^*_L} + \frac{\partial V}{\partial R_L} \frac{\partial R_L}{\partial R^*_L} \right) N(d_1) \right] - \left( 1 + R \right) \left( \frac{\partial L}{\partial R^*_L} + \frac{\partial L}{\partial R_L} \right) e^{-\mu} N(d_2) = 0 \quad (16b)$$

We note that the conjectural variations of operating together do not exist because the combined banks produce their own loans in different “plants” even though the combined banks are imperfectly competitive. The first-order conditions in equations (16a) and (16b) determine the optimal loan rates; accordingly, the earning-asset portfolios. Equation (16a) implies that the acquirer bank sets its optimal loan rate, $R_L$, at the point where the proportion of the combined banks owned by the acquirer bank’s shareholders, $\theta$, multiplied by the marginal equity value of $R_L$.

if the acquirer bank cannot resist the temptation to look into the performance consideration. The target function of equation (15) in this model provides a useful tool for the acquirer bank’s acquisition decision.
of the combined banks equals the “own” marginal equity value of $R_L$ of
the acquirer bank if operating individually. Equation (16b) implies that
the acquirer bank set its optimal loan rate, $R_L^*$, at the point where the
proportion $\theta$ multiplied by the marginal equity value of $R_L^*$ of the com-
bined banks equals the “cross” marginal equity value of $R_L^*$ of the acquirer
bank if operating individually. Based on rather general assumptions, it is
reasonable to believe that the marginal equity value of $R_L^*$ is greater than
the cross marginal equity value of $R_L^*$ at least in the short run.

Accordingly, the marginal equity value of $R_L$ of the combined banks
is expected to exceed that of $R_L^*$ of the combined banks. This result is
intuitive because the combined banks may have comparative advantages
to conduct $R_L$ rather than $R_L^*$ since the combined banks are in general
managed by the acquirer rather than the acquired bank.

To analyze the comparative statics derived from equation (16a) and
(16b), we require that the second-order and the stability conditions be
satisfied. They are:

\[
\Delta \equiv \frac{\partial^2 I}{\partial R_L^2} \frac{\partial^2 I}{\partial R_L^*} \frac{\partial^2 I}{\partial R_L^*} > 0, \quad \frac{\partial^2 I}{\partial R_L^2} < 0, \quad \frac{\partial^2 I}{\partial R_L^*} < 0.
\]

The assumption $\frac{\partial^2 I}{\partial R_L^2} < 0$ ($\partial^2 I/\partial R_L^* L^2$) shows that the acquirer
bank’s marginal net gain value of $R_L$ ($R_L^*$) from the acquisition must
fall when $R_L$ ($R_L^*$) is set increasingly. Because both optimal loan rates are
simultaneously determined by the acquirer bank to maximize the net gain
from the acquisition, terms $\frac{\partial^2 I}{\partial R_L \partial R_L^*}$ and $\frac{\partial^2 I}{\partial R_L^* \partial R_L}$ demonstrate
the acquirer bank’s interactive operation between its two heterogeneous
loan-rate settings. $\frac{\partial^2 I}{\partial R_L \partial R_L^*}$ can be represented in the following way:
the change in the expected marginal equity value to the loan-rate ($R_L$)
setting of the combined banks as influenced by the change in the other
loan-rate ($R_L^*$) setting. By applying Bulow, Geanakoplos and Klemperper
(1985), the acquirer bank believes that its own loan-rate settings of $R_L$ and
$R_L^*$ have the nature of a strategic substitute if $\frac{\partial^2 I}{\partial R_L \partial R_L^*} < 0$;
and a strategic complement if $\frac{\partial^2 I}{\partial R_L \partial R_L^*} > 0$. We further assume that
$\Delta > 0$. These assumptions insure that a unique symmetrical equilibrium
exists in the acquirer bank conducting strategic substitutes or strategic
complements.

A strategic substitute between two heterogeneous loans suggests that
the acquirer bank increasing (decreasing) its loan rate setting ($R_L$) is the
best response when it decides to decrease (increase) its other loan rate
(\(R^*_L\)). The best response when the acquirer decides to increase (decrease) its other loan rate (\(R^*_L\)) as it increases (decrease) its loan rate setting (\(R_L\)) is a strategic complement. Rather than emphasizing a bank and its rival’s competitive strategy in Bulow, Geanakoplos and Klemperper’s sense, this paper expresses a loan’s interactive strategy conducted by the acquirer bank to maximize the net gain from the acquisition. A bank acquisition can be viewed as a corporate-control transaction. A bank needs strategies for operating and competing in the market for corporate control. It is assumed that both loan markets faced by the acquirer bank are imperfectly competitive so that rate setting is the relevant behavioral mode not only in both markets but also in management itself. A strategic substitute/complement in this paper suggests a strategy that integrates a corporate-control transaction with the market conditions and rate-setting behavioral modes of the acquirer bank. \(\frac{\partial^2 I}{\partial R^*_L \partial R_L}\) can be correspondingly explained as \(\frac{\partial^2 I}{\partial R^*_L \partial R_L}\).

In this model with the net gain maximization of the strategic acquisition, the effect of changes in the proportion of the combined banks owned by the acquirer bank’s shareholders \(\theta\) on the acquirer bank’s loan-rate setting is explored in the following:

\[
\frac{dR_L}{d\theta} = -\frac{1}{\Delta} \left[ \left( \frac{\partial M}{\partial L} \frac{\partial L}{\partial R_L} + \frac{\partial M}{\partial L^*} \frac{\partial L^*}{\partial R_L} \right) \frac{\partial^2 I}{\partial R^*_L \partial R^*_L} \right. \\
- \left. \left( \frac{\partial M}{\partial L} \frac{\partial L}{\partial R^*_L} + \frac{\partial M}{\partial L^*} \frac{\partial L^*}{\partial R^*_L} \right) \frac{\partial^2 I}{\partial R_L \partial R^*_L} \right] \\
\times \left[ \left( N(a_1) - (1 + R)e^{-\mu}N(a_2) \right) \right]. \tag{17}
\]

An explanation of equation (17) is possible in terms of: (i) product effect (substitutes or complements of the two loans), (ii) interactive operation effect (strategic substitutes or strategic complements) and (iii) risk effect (the risk adjustment factors of the combined banks’ assets and net obligations). The product effect is related to the nature of the combined banks’ two distinct yet interrelated loans. The interactive operation effect is related to the best responses of the combined banks’ loan-rate settings in their multiple-plant-multiple-product operations. Equation (17) indicates that an increase in \(\theta\) decreases the loan rate setting \(R_L\) only if the product effect is negative (complements), the interactive operation effect is positive (strategic complements) and the risk effect is positive (the risk adjustment factor of the assets are sufficient to cover that of the net obligations).
It is reasonable to believe that the nature of the product effect determines the interactive operation effect. However, this paper illustrates that $\theta$ is negatively related to $R_L$ under a possible constraint by the three effects mentioned as above. It is also possible to have the products as substitutes and yet have strategic complements if the risk effect alters.

The give-and-take of the negotiation process determines both the acquisition cost and amount paid to the acquired bank’s shareholders. In the negotiation, the acquired bank tries to maximize the benefit from the acquisition (maximizing $\delta$ in the model) whereas the acquirer bank tries to minimize the cost (maximizing $\theta$). As mentioned earlier, Rose (1987) showed that the acquirer bank is significantly less profitable than the acquired bank in returns earned for shareholders. $\theta$ is expected to be relatively low. Under these circumstances, the acquirer bank is allowed to utilize the loan-rate-setting strategy to maximize its benefit from the acquisition.

As pointed out by Vennet (1996), an acquirer bank can raise its product prices after acquiring competitors by gaining monopoly power through horizontal mergers. Rose (1993) found that an acquirer bank that did achieve higher post-merger returns was frequently aided by increases in market concentration that resulted from its acquisition. A bank with improving post-merger returns also displayed stronger control over loan losses. Accordingly, an acquirer bank is expected to increase its product prices after acquiring competitors. A loan-rate-setting acquirer bank facing a low $\theta$ may attempt to increase its loan rate when there is a negative product effect, a positive interaction effect and a positive risk effect. The above finding is consistent with the theory that the driving force behind acquisition is to gain market power. The synergistic benefits from combining two banks into one with reducing costs and increasing efficiency are generated not through substitution but by complementing each bank’s product’s strengths. We argue that the portfolio-theoretic analysis of risk effect and the firm-theoretic analysis of product and interactive operation effects have an important relationship that can be used to analyze the cost-benefit analysis of an acquirer bank’s acquisition decisions under uncertainty.

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9In general, there are three types of mergers and acquisitions: horizontal, vertical and conglomerate mergers. Complementarity in this model may be treated as conglomerate mergers which can create or reinforce market power since both the acquirer and the acquired banks facilities tacit collusion as well as diversification.
Consider next the impact on the acquirer bank’s loan rate from a change in the capital-to-deposits ratio. The total changes in $R_L$ from a change $q$ is:

$$
\frac{dR_L}{dq} = -\frac{1}{\Delta} \left\{ \left[ \theta \left( \frac{\partial M}{\partial L} \frac{\partial L}{\partial R_L} + \frac{\partial M}{\partial L^*} \frac{\partial L^*}{\partial R_L} \right) G_a 
- \left( \frac{\partial L}{\partial R_L} + \frac{\partial L}{\partial R^*_L} \frac{\partial R^*_L}{\partial R_L} \right) G_d \right] \frac{\partial^2 I}{\partial R^*_L} \left( \frac{\partial^2 I}{\partial R^*_L \partial R^*_L} \right) \right\} (18)
$$

where,

$$
G_a = \left( \frac{\partial N}{\partial \tilde{a}_1} - (1 + R)e^{-\mu} \frac{\partial N}{\partial \tilde{d}_2} \right) \frac{\partial \tilde{a}_1}{\partial q},$

$$
G_d = \left( \frac{\partial N}{\partial \tilde{d}_1} - (1 + R)e^{-\mu} \frac{\partial N}{\partial \tilde{d}_2} \right) \frac{\partial \tilde{d}_1}{\partial q}.
$$

The interpretation of the result follows a similar argument as in the case of a change in $\theta$. The acquirer bank’s decision for external growth through an acquisition strategy generally requires raising new capital to purchase a controlling equity interest in the acquired bank. This decision is complicated by the existing capital structures of both the acquirer and the acquired banks and by the regulatory capital requirements. Capital regulation in bank mergers and acquisitions is inevitably a regulatory intervention, the process through which the banking authorities attempt to correct a perceived unsafe or unsound banking practice. Given the concern about the intervention of capital regulation in bank mergers and acquisitions, an optimal adjustment on the acquirer bank’s loan-rate setting is required to maintain the net gain maximization from its strategic acquisition investment.

$G_a$ can be viewed as a marginal risk effect of capital regulation of the multiple loans and $G_d$ can be that of the acquirer bank’s loan. We assume that $G_a$ and $G_d$ are positive since the bank authority attempts to correct a perceived unsafe banking practice by increasing the capital-to-deposits ratio. The result of equation (18) is stated as follows. An increase in the capital-to-deposit ratio decreases the acquirer bank’s loan-rate setting ($R_L$) under $\partial R_L / \partial R^*_L = 0$ (Cournot-type “adjusted variation”), the negative product effect (complements) and the positive interactive operation
effect (strategic complements). As the acquirer bank is regulated by an increase in the capital relative to deposit level, it must provide a return to a larger equity base in its acquisition activity. One way the acquirer bank may attempt to augment its total returns from the acquisition is by shifting its investments to its loan portfolio and away from the open market securities. If loan demand is relatively rate-elastic, larger loan portfolio is possible at a reduced loan rate.

The interpretation of equation (18) follows Zarruk and Madura’s model in the case of decreasing or constant absolute risk aversion. We argue that the negative relationship between loan-rate setting and capital regulation in this paper can be explained not only by the risk effect but also the product effect and the interactive operation effect. Therefore, this paper sheds light upon risk effect (portfolio-theoretic analysis) and product and interactive operation effects (firm-theoretic analysis) in capital regulation and acquisition.

5. Conclusions

Bank acquisitions are observable forms of behavior that reflect this decision. As such, bank acquisitions offer an opportunity for observing banking motivations and behavior in details. A microeconomic model of a loan-rate-setting bank’s acquisition decision under uncertainty was proposed in this paper that focused on a contingent claim analysis. The distinguishing characteristic of this model is that loan-rate-settings, the give-and-take or the negotiation on premiums paid in acquisition and capital regulation are simultaneously incorporated into the model. Based on a realistic view of an acquirer bank’s acquisition decision, it seems that the conditions listed above are important and necessary. More importantly, these considerations play an important role in determining loan-rate decisions (the firm-theoretic approach) and hence optimal loan portfolio (the portfolio-theoretic approach) in bank acquisitions using a framework based on the Black-Scholes formula.

Emphasizing the acquisition decision associated with uncertainly under loan-rate conducting behavioral modes, there are two conclusions

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10Cournot-type conjectural variation as it is commonly called is usually described as a competitive behavior between firms. Rather than using the term “conjectural variation”, we use “adjusted variation” since a multiple loan function, \( M(L(R_L, R^*_L), L^*(R_L, R^*_L)) \), of adjusting operation between loans by the acquirer bank is modeled in this paper.

11Zarruk and Madura (1992) examined the relationship between capital regulation and the optimal bank interest margin. This paper investigated the relationship between capital regulation and the optimal acquirer bank’s loan rate.
suggested by the model in this paper. First, the acquirer bank’s give-and-take negotiation result expressed by the proportion of the combined banks owned by the acquirer bank’s shareholders has a direct impact on its loan rate setting with the net gain maximization in the acquisition decision. In particular, we show that a decrease in this proportion increases the acquirer bank’s loan rate setting under the negative product effect, the positive interactive operation effect, as well as the positive risk effect. The above finding is consistent with the theory that the driving force behind acquisition is gaining market power. Second, we show that the capital regulation has a negative effect on the acquirer bank’s loan rate setting behavioral modes under the Cournot-type adjusted variation, the nature of loan complements and the operation of loan strategic complements. A strategic option, the contemporary model presented in this paper, provides an alternative explanation for the acquirer’s bank strategies for operating and competing in the market under capital regulation that goes beyond those attained through traditional bank acquisition strategies.

References


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