Quantitative Finance and Economics

QFE, 3(1): 53–74.
DOI: 10.3934/QFE.2019.1.53
Received: 24 November 2018
Accepted: 27 February 2019
Published: 07 March 2019

http://www.aimspress.com/journal/QFE

Research article

How does soft information about small business lending affect bank efficiency under capital regulation?

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Abstract: In this paper, we develop a capped call option model to evaluate the equity of a bank under capital regulation. A capped type of credit risk from the performance of relationship borrowing firms is explicitly considered, captured by a mechanism through borrower soft information that the bank produces and accumulates. We study the impact of soft information for small business lending on the optimal bank interest margin, i.e., the spread between the loan rate and the deposit rate of a bank. Our findings show that favorable soft information increases small business lending at a reduced loan rate (and thus at a reduced margin), and further lowers bank equity risk and enhances efficiency gains from soft information acquisition when borrower dependent on bank financing is heavy. Moreover, we account for the capital regulatory environment stringent to small business lending that increases bank equity risk and decreases soft information efficiency gain. Our results have important bank interest margin implications in terms of achieving efficiency gain and lower risk exposure, which might conflict with capital regulation aiming to promote financial stability.

Keywords: soft information; capital regulation; efficiency gain; capped call

JEL codes: G21, G28

1. Introduction

Voluminous studies have investigated the importance of soft information, that is, information that requires the subjective interpretation by the loan officers who collect it and that cannot be

credibly transmitted to others, for making small business loans.[1] Soft information remains a crucial input for small business lending because small borrowing firms usually experience difficulties raising capital through external debt financing and then are heavily dependent on bank financing (Chen et al., 2015). Small borrowing firms generally do not have sufficient tangible assets to pledge as collateral, and their financial statements are not transparent enough. Recently, the subprime-related 2007/2008 global financial crisis raises fundamental issues about the role of bank capital, in particular that post-crisis reform proposals tend to focus on how capital regulation should adapt to prevent future crises. Many recent studies, for example, Kashyap et al. (2008), Acharya et al. (2012), and Hart and Zingales (2011) have investigated the economic impacts of capital regulation. However, these studies have not particularly investigated the mechanism through which small business lending invokes a detrimental effect on relationship borrowers. The investigation of stringent bank capital requirement on credit availability or performance of relationship borrowers is intriguing because such borrowers have strong transactional relationships with the bank, and most likely to be affected by capital regulation. The goal of this paper is to incorporate borrower soft information into the firm-theoretical model of a bank facing credit risk under capital regulation.

The bank interest margin, i.e., the spread between the loan rate chosen by the bank and the deposit market rate in our model, is often used in the literature as a proxy for the efficiency of financial intermediation (Saunders and Schumacher, 2000).[2] In practice, bank spread is determined through a "cost of goods sold" approach in which deposits are the "material" and loans are the "work in progress" (Finn and Frederick, 1992). Banks usually specialize in different sectors of the small business lending market depending on the type of soft information. Complementing the literature on bank interest margin, this paper is to follow this approach to characterize soft information about the small borrowing firms by a lending function that explicitly creates risk characteristics. In the paper, we construct a contingent claim model along the line of Dermine and Lajeri (2001) for the valuation of the equity of a bank. Their main contribution is to explicitly consider default risk to value the equity of a bank where default can occur at the maturity date. However, first, a weakness of their model is that it evaluates shareholders' claims only in the perfectly competitive financial markets. The micro-model of the banking firm (see, for example, Zarruk and Madura, 1992; Wong, 1997, 2011) views the banking firm in a static setting where the loan market faced by the bank is imperfectly competitive. Despite the limited formulation, default related to borrower soft information captured by structure breaks is not explicitly considered. Second, we examine the bank's interest margin determination with an explicit treatment of borrower soft information, while most of the extant research analyzes the bank interest margin issue remaining largely silent on this issue. As pointed out by Godbillon-Camus and Godlewski (2005), borrower soft information related to risk management in banks is a crucial input for financial intermediation. In general, banks are confronted to information's asymmetry problems because of borrowers' informational opacity.

The purpose of this paper is to develop a contingent claim model of bank spread behavior that integrates the borrower risk considerations and soft information acquisition of the portfolio-theoretic

[1] Soft information of the borrowing firm may be defined as that which is hard to communicate in a verifiable manner, such as an entrepreneur's competence and employee morale, is accessible exclusively from the bank firm with strong transactional relationship with the borrowing firm, and is, thus, a factor that primarily makes a bank-borrowing firm relationship special (Stein, 2002; Ogura and Uchida, 2014).

[2] In the findings of Saunders and Schumacher (2000), interest margins, the spread between a bank's interest earnings and expenses as a percent of interest-earning assets, vary widely across banks, both within and across the OECD countries during the 1988–1995 period. Adding this complex margin specification affects none of the qualitative results in our model.

approach with the efficiency conditions, capital regulation considerations, and loan rate-setting behavioral mode of the firm-theoretic approach. Two main results are as follows. First, we find that an increase in favorable soft information about the borrowing firm decreases the small business loan amount held by the bank at a reduced interest margin. This finding implies that the borrowing firm with more favorable information acquired by the bank enjoys a lower loan rate. We also show that the production of soft information, if favorable, can stabilize the bank's equity risk and improve the efficiency gain when the borrower's leverage dependent on bank financing is large. Accordingly, we can argue that favorable soft information is really valuable to banks for extending small business loans. Second, we show that an increase in the capital-to-deposits ratio increases the bank's small business loans at a reduced interest margin. The positive effect of capital regulation on the bank's small business loans is more significant when its borrowing firm's leverage is high than when the leverage is low. We can argue that the borrowing firm with favorable soft information enjoys a lower loan rate when the bank capital requirement is increased. Capital regulation as such leads to superior bank efficiency gain from favorable soft information when the borrowing firm's leverage is high. This may suggest that research on bank interest margin related to risk management should put forward the importance of information's treatment in order to increase estimation's precision of borrowers' quality in the small business lending under capital regulation.

The rest of the paper is organized as follows. Section 2 discusses related literature. Section 3 develops the basic structure of the model. Section 4 derives the solution of the model and the comparative static results. Section 5 conducts a numerical analysis to explain the intuition of the results. The final section concludes the paper.

2. Related literature

In the literature, various papers examine the relationship between soft information and small business lending in order to overcome the problems caused by the borrowers' opaque financial statements. Our theory of soft information for making decisions for small business loans is related to the following strands of the literature. The first strand is the literature on bank interest margin determination. Elements affecting bank interest margins have been well examined in the banking literature. This is an important issue since bank interest margin conveys vital information about banking efficiency. Ho and Saunders (1981) focus on two basic components of the bank's interest margin determination, the market competition, and the interest rate risk. Angbazo (1997) argues that both credit risk and interest rate risk are crucial to affecting bank interest margin determination. The extension of Ho and Saunders (1981) is studied by Maudos and de Guevara (2004), who includes operating cost as an explicit component of bank interest margin. Kasman et al. (2010) study the impact of the explanatory variables on bank interest margin. The explanatory variables include operating cost, credit risk, default risk, capital adequacy, managerial efficiency, Lerner index, deposit to equity, and capitalization. Huang et al. (2018) develop a barrier cap option model to examine the optimal interest margin and the default risk in the bank's equity returns under capital regulation. Literature on bank interest margin largely emphasizes hard information for banking efficiency. While we also study bank interest margin, our focus on the margin determination with soft information for making small business loans takes our analysis in an alternative direction toward bank spread behavior mode.

The second strand is the literature on the importance of soft information for small business lending. Berlin and Mester (1998) focus on the profitability and cost of relationship lending and demonstrate banks often considering soft information when they make credit-funded decisions on small business loans. Stein (2002) analyzes information production and capital allocation particularly about the issue of the decentralized versus hierarchical firms and concludes that managers of small banks have more incentives to produce soft information. The result is understood because loan managers at small banks have a higher authority to make loan decisions than those at large banks, so the soft information they acquire is more likely to be made in the decision whether a loan will be granted (Chen et al., 2015). This conclusion implies that small banks have an advantage relative to large banks in extending small business loans. Cole et al. (2004) conclude that small-scale banks rely much more on borrower soft information for loan approval decisions than large-scale banks. McCann and McIndoe-Calder (2015) examine the relationships among firm size, credit scoring accuracy and banks' production of soft information. The authors suggest that large-scale banks are less likely to engage in relationship banking. Chen et al. (2015) empirically investigate the value of soft information, information that requires the subjective interpretation by the loan officers who collect it and cannot be credibly transmitted to others, for making small business loans. The authors find that soft information variables have significant power to predict defaults of small business borrowers. Furthermore, soft information affects the terms of loan contracts; borrowers with better soft information obtain lower interest rates for their loans. Some recent studies discuss how technology is changing the information available about small and medium enterprises, which in turn alters the nature of relationship lending itself. Allee and Yohn (2007) determine the factors associated with the production and use of financial statements by small businesses in the absence of regulation. The authors find that firms with audited financial statements benefit in the form of greater access to credit and that firms with accrual-based financial statements benefit in the form of a lower cost of credit. Using bank-level loan exposures, Berger et al. (2017) find that the propensity across banks to collect audited financial statements from borrowers is lower for banks with more concentrated commercial loan portfolios, suggesting that concentration is an important characteristic that affects information collection practices of banks. Their results support the joint hypothesis that the concentration of bank exposures is related to the expertise of the bank and that this expertise substitutes for high-quality information, such as audited financial statements. Sutherland (2018) examines how credit reporting affects where firms access credit and how lenders contract with them. The author finds that information sharing reduces relationship switching costs, particularly for firms that are young, small, or have had no defaults. The primary difference between our study and these papers is that we consider the effects of soft information and capital regulation on bank interest margin determination and efficiency gain from borrower soft information. This is a supportive issue since small-size borrowing firms heavily dependent on bank financing are more likely to be affected by bank capital regulation.

The third strand is the literature on putting forward distinctions to be made between hard and soft information. This is an important issue since the role of information's processing in bank intermediation is a crucial input for making small business loans.[3] As demonstrated by Godbillon-Camus and Godlewski (2005), there are three types of dimensions used to distinguish hard information from soft information: nature, collecting method, and cognitive factors. The authors investigate the impacts of the three information's types on credit risk management in a principal-agent framework. The results show that access to soft information allows bank managers to

[3] See Petersen (2004) for a recent literature review about putting distinctions between hard and soft information.

decrease the capital allocation for Value at Risk (VaR) coverage, and the existence of incentives of the credit managers to manipulate the signal reaction from soft information that they produce. Berger and Udell (2002), and Elsas (2005) argue that soft information has some advantage to increase the predictive capacity of hard information, which aims at investigating qualitative factors' impact on default risk prediction. In Grunert et al. (2005), considering soft information in risk analysis is expected to increase estimation's precision of borrowers' quality. However, Godbillon-Camus and Godlewski (2005) argue that soft information in Grunert et al. (2005) is not verifiable and therefore manipulable. This type of information can affect credit risk management in banks and has an impact on bank organization structure. Soft information should be adapted in order to avoid the consequences and costs of manipulation. What distinguishes our work from this literature is our focus on an analysis of efficiency gain from soft information under capital regulation. As we discuss further below, our model confronts two types of information (hard as well as soft) captured by structural breaks in a geometric Brownian motion, and a type of borrower-capped lending structure in the context of relationship banking.

The fourth strand is the literature on bank capital regulation. Several papers suggest that higher capital should enhance bank profitability (e.g., Allen et al., 2011; Berger and Bouwman, 2013), while others argue that it should lead to a reduced return on equity (e.g., Acharya and Mora, 2015). Many papers suggest that capital improves a bank's equity risk and thus survival probability (e.g., Allen et al., 2011; Acharya et al., 2012). Some theories seem to suggest that the result above might not hold (e.g., Calem and Rob, 1999; Diamond and Rajan, 2001). From a normative standpoint of bank performance and financial stability, several related papers (e.g., Kashyap et al., 2008; Acharya et al., 2012; Hart and Zingales, 2011) document that social efficiency can be improved by requiring banks to operate with more capital, especially during financial crises. Berger and Bouwman (2013) demonstrate that public outcries for more bank capital tend to be greater after financial crises, and post-crisis reform proposals tend to focus on how capital regulation should adapt to prevent future crises. However, literature has pointed out some negative consequences of more capital (e.g., Aiyar et al., 2014; Osborne et al., 2017; Jiménez et al., 2017). While we also discuss bank capital regulation, our focus on how borrower soft information and capital regulation affect the bank's performance takes our analysis in a different direction.[4]

Before proceeding with the development of the model, we review several determinants of the intensity of soft information acquisition by banks, or the amount of soft information accumulated by banks. Berger and Udell (2002) point out that small business lending decisions by banks are likely to be made on the basis of qualitative information of borrowing firms, such as the competence, enthusiasm, morale, or skills of entrepreneurs and employees. Uchida et al. (2012) focus on the role of loan officers in producing soft information and further investigate the determinants of soft information production by banks. Specifically, the soft information production function is defined as a function of loan officer activities, relationship strength, bank size/type dummies, and control variables. Ogura and Uchida (2014) provide a measure of soft information including knowledge of the responding firm, the firm's owners and managers, the industry to which the firm belongs, the local community where the firm is located, the market for the products/services of the firm, and the frequency of contacts by loan officers of a main bank. Chen et al. (2015) define two sets of soft

[4] Different types of lending (e.g., mortgages or consumer loans) require different internal risk processes, which make the appropriate capital allocation and regulatory standards different (see, for example, Calem and LaCour-Little, 2004; Crook and Bellotti, 2010; Carlson et al., 2013). We believe our approach is sufficiently general that it can be adapted to alternative numerical specifications based on application of contingent claim valuation to other types of lending.

information, non-financial and financial ones, to investigate the value of soft information for making small business loans. The non-financial soft information includes employee, leadership, regulation, macroeconomic factor, competitiveness, quality, customer, marketing team, and public praise. The financial soft information includes leverage, liquidity, turnover, profit, and growth. Complementing the above literature, this paper abstracts from individual soft information variables and theoretically assesses soft information acquisition by loan valuation that follows a structure-break lognormal process, and by the risk characteristics of small business loans that creates the need to model equity as a capped call option. Our complement will be explained in a later section.

3. Model framework and assumptions

This section mainly consists of two parts. The first part describes several simplifying assumptions and the conceptual framework. The remaining of this section focuses on the valuation of the bank's equity return and equity risk and of the efficiency gain/loss from soft information for making small business loans.

3.1. Assumptions

Several assumptions are made in order to get tractable solutions. We shall point out when these made assumptions affect the qualitative solutions derived in the model. First, a contingent claim approach is applied to a bank-borrowing firm situation. Our model is fundamentally based on Merton's (1974) contingent-claim approach to financial intermediaries. A key advantage of the contingent-claim analysis is that it captures the shareholders' option to walk away when things go wrong in their bank. Specifically, we consider a relationship banking of the bank and the borrowing firm whose planning horizon extends over a given time interval with two dates 0 and 1, $t \in [0,1]$. Date $t=1$ is the time at which the bank is subject to a comprehensive on-site audit by the regulatory authority. The audit purpose is to evaluate the bank's equity value and to check that it is solvent. If the audit assets are found to be less than liabilities, the bank's assets are costlessly transferred to its liability holders, and the value of the bank's equity is zero. The reason is that the shareholders of the bank are residual claimants on its assets after all liabilities have been met.

Second, we assume that the bank has some market power in its loan market. Such a market is usually concentrated in the sense that the bank sets the loan rates and faces random loan levels.[5] Furthermore, to capture the issue of soft information and small business lending, it is natural to say that there are many small-scale borrowing firms who are interest rate takers in the loan market. Without loss of generality, the model presented in the paper considers the case of one bank (the rate setter) and one representative borrowing firm (the rate taker) in the loan market. The former can be motivated based on a bank interest margin determination argument, while the latter can be motivated based on a variety of factors, including soft information and the bank financing risk characteristics of borrowed assets in our model. The administrative cost of loans is ignored in the model. An assumption about increasing administrative costs of making loans would achieve the same end.

[5] McMillan and McMillan (2016) find an increase in the banking concentration and market power in relation to competition since the recent financial crisis period. However, competition among banks in the loan market is not considered in our model. More complex cases focusing on conjectural variations in an oligopolistic loan market could be analyzed that we are silent on.

Third, any claim in the bank's earning-asset portfolio can be replicated in the market place by a combination of other financial assets due to the assumption of complete financial markets. The price of any asset is identical to the value of replicating portfolio in order to avoid any arbitrage opportunity. As pointed out by Zarruk and Madura (1992), a bank's objective is, in general, to maximize its market value if the assumption of complete capital markets is made. Based on the completely replicated mechanism, market values for the financial claims on the bank's and the borrowing firm's assets can be determined (Crouhy and Galai, 1991). Accordingly, a contingent claim approach can be applied to a bank-borrowing firm situation in our model.

In the following, we develop a basic model of bank efficiency gain/loss from soft information acquisition in small business lending. Soft information acquisition can be motivated based on a relationship banking argument in the spirit of Boot (2000). Since changes in borrower soft information may affect bank lending behavior, we focus solely on the bank interest margin determination without considering competition changing the benefits of bank-borrower relationships. Our aim is to take insolvency risk explicitly into account. We, therefore, consider a contingent claim model framework for a banking firm based on a model proposed by Merton (1974) and inspired by the model of Dermine and Lajeri (2001) whose description we partially adopt in the following subsection.[6]

3.2. Equity and efficiency valuation

Table 1. Balance sheets in a bank-borrowing firm situation at $t=0$.

Borrowing firm				Bank			
Asset		Liability and equity		Asset		Liability and equity	
assets	A_b	bank loans	L	loans	L	deposits	D
		firm equity	K_b	liquid assets	B	bank equity	K

At $t=0$, the balance sheets look like what is shown in Table 1 of the bank-borrowing firm situation. The borrowing firm is funding an asset $A_b>0$ with the bank's loans $L>0$ and equity capital $K_b>0$. Given both the balance sheets of the borrowing firm and the bank, the leverage ratio of L/A_b is demonstrated as a degree of the borrowing firm's bank financing dependence. This ratio plays an important role in a relationship banking environment since there is an overvaluation or an undervaluation of the bank loans at various degrees of borrower leverage in particular which likely affects bank efficiency gain/loss from soft information acquisition in our model. Table 1 also demonstrates that the bank funds the earning-asset portfolio including L and risk-free liquid assets $B>0$ with deposits $D>0$ and equity capital $K>0$.[7] The bank's loans mature at $t=1$. The demand for loans faced by the bank is governed by a downward-sloping demand function $L=f(R_L)$ where the loan rate R_L is set by the bank. Under the circumstances, the representative borrowing firm is a loan-rate taker in the loan market where it has no bargain power for its funding as mentioned previously.[8] Here, we assume that the representative firm is small-scale in order to

[6] To the best of the authors' knowledge, this is the first paper to offer an option pricing model to theoretically analyze soft information acquisition incentives. For related empirical studies, see, for example, Wang (2012), Karapetyan and Stacescu (2014), and Ogura and Uchida (2014).

[7] The liquid assets of the bank include reserves which has the same return rate as other liquid assets (such as government bonds) and the equity capital. This is a convenience in modeling as this paper does not focus on reserve ratio constraint.

[8] Dermine and Lajeri (2001) model a one-bank-one-borrower framework in a capped call option valuation where both the bank and the borrower are assumed to face the competitive market conditions.

explicitly discuss soft information acquisition for small business lending in our model.[9] This is because the financial statement of the small-scale borrowing firm may be not transparent enough (Chen et al., 2015).[10]

To capture a relationship borrower depending on bank financing, we apply Merton (1974) and assume that the equity of the borrowing firm is viewed as a call option on its assets. Equity holders are recognized as residual claimants on the firm's assets after all other obligations have been met. The strike price of the call option is the book value of the firm's liabilities, the loan repayments from the firm to the bank $V=(1+R_L)f(R_L)$ at $t=1$. When the value of the firm's assets is less than the strike price, the value of equity is zero. The call option presented in the model considers the case of one bank and one borrower with assets that follow a lognormal process. Specifically, we model the structure breaks in return and volatility using a form of a geometric Brownian motion with two state variables, one capturing benefit from favorable borrower soft information acquisition and another reflecting cost of information acquisition. Both the structure breaks extract the subjective components of the bank's credit assessment of its small business borrowing firms by orthogonalizing the parameter values that the bank assigns to borrowing firms with public information about the credit quality of the borrowing firms. The setting is closely related to Agarwal and Hauswald (2010). As we discuss further below, the form can be motivated based on enlarging bank asset return, while the latter can be captured by increasing bank asset risk in the cost-benefit setting. Accordingly, the market value of the firm's underlying asset follows a geometric Brownian motion of the form:

$$dA=(\mu+\alpha)Adt+(\sigma+\alpha)AdW \tag{1}$$

where $A=(1+R_A)A_b$ is the expected return from the borrowing firm's investment at $t=1$ where $R_A>0$ is the expected rate of return, and W is a standard Wiener process. The value of expected investment return A is the value with an instantaneous drift $(\mu+\alpha)>0$ and an instantaneous standard deviation $(\sigma+\alpha)>0$ where $\mu>0$, $\sigma>0$, and $\alpha>0$. μ and σ are generally explained as hard information about the borrowing firm such as non-financial hard information about history, wealth, experience, and accountant, and financial hard information about leverage, liquidity, turnover, profit, and growth.[11] The structural break parameter α is assumed to be positive in sign that demonstrates favorable soft information for the small business loans, for simplicity, captured by increased the expected investment return (benefit from soft information acquisition) and the volatility of the return (cost of soft information).[12] Parameter α can be explained as soft information,

[9] One could consider a more realistic case of the bank lending to many small-size firms. The mathematics would be slightly different from the one presented in the paper. The conclusions resulting from the case of a small-size firm would hold completely.

[10] The adverse selection problem under asymmetric information is ignored in the model's setting. The finance literature has long recognized that market imperfections such as information asymmetries and agency conflicts affect corporate finance and investment. The classic adverse-selection model of Myers and Majluf (1984) predicts that asymmetric information between informed managers and the public market causes underinvestment. Wu and Wang (2005) generalize the Myers and Majluf (1984) model and find that if asymmetric information is largely about growth opportunities, the adverse selection effect does not necessarily exist. Since the soft information appears in both the drift and volatility terms of the model in this paper, the firm is likely to be high growth firm type (see also Wu and Au Yueung, 2012). We thank an anonymous reviewer whose detailed comments helped us to avoiding ignoring the above issue in the financial literature.

[11] For example, the variable of leverage is specified as the sum of the preliminary scores for financial ratios regarding leverage, including capital ratio, financial debt to equity, and long-term capital to fixed assets (see Chen et al., 2015).

[12] Our model is limited to the case of favorable soft information with equaled increased return and risk. However, this model is also applicable to the case of negative soft information when $\alpha<0$, $(\mu+\alpha)>0$, and $(\sigma+\alpha)>0$. Adding this complexity affects none of qualitative comparative static results in the paper.

including non-financial and financial soft information as mentioned in the previous literature review section.[13] In equation (1), integrating the soft information considerations with the hard information conditions reflects the discontinuity of risky asset return and volatility by structure-break changes. Specifically, α represents the structural changes caused by favorable soft information about the mean and volatility making A higher. Note that the structural break α explicitly evaluates the return and risk of borrower soft information acquisition through multiple interactions with the borrowing firm's investment in the relationship banking.[14] Equation (1) can also describe a variable relationship banking captured by $A_b = f(R_L) + K_b$. The value of A_b depends on $f(R_L)$ where R_L is determined by the bank, and further on a leverage ratio of $f(R_L)/A_b$ related to the initial capital stock K_b held by the borrowing firm.

As shown in Table 1, at $t = 0$, the bank has the following balance sheet: $L + B = D + K$. Loans are risky in that they are subject to non-performance explicitly capped by the borrowing firm's investment. The liquid assets held by the bank earn the security-market interest rate of $R > 0$. The total assets to be financed at $t = 0$ are $L + B$, which are financed partly by deposits. The supply of deposits is assumed to be perfectly elastic at the constant deposit market rate $R_D > 0$. Bank equity capital is tied by capital regulation to be a fixed proportion q of the bank's deposits $K \geq qD$ where q is a required capital-to-deposits ratio (VanHoose, 2007). When the capital constraint is binding, the bank's liquidity constraint can be restated as $L + B = K(1/q + 1)$.[15]

The bank's objective is to set R_L to maximize the market value of a caped call option function defined in terms of the bank's net equity returns, subject to the bank's balance-sheet constraint and the borrowing firm's performance. By applying the option pricing framework (see Dermine and Lajeri, 2001), the market value of the bank's net equity can be assessed. As is well known from option theory (Black and Scholes, 1973), the market value of the bank's equity E can be specified as a capped call on the bank's underlying asset portfolio, that is

$$\underset{R_L}{\text{Max}}\, E = \textit{Capped Call}\,(\text{Value of loan}, Z) = \textit{Capped Call}\,(V - \textit{Put}\,(A, V), Z) \tag{2}$$

i.e. the ability to buy the asset of the bank at an exercise price Z, and where

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

is the book value of the net-obligation payments, i.e., the difference between the payments to depositors and the opportunity-cost payments to shareholders and the repayments from the liquid-asset investment. Equation (2) explains the ability to buy the bank's asset of $V = \textit{Put}\,(A, V)$ at a strike price of Z. Given the limited liability of the borrowing firm, the value of the loan

[13] See Chen et al. (2015). In addition, for example, the leverage variable of the financial soft information in the empirical study of Chen et al. (2015) is defined as the sum of the adjustments made by loan officers on the scores for the capital ratio, financial debt to equity, and long-term capital to fixed assets.

[14] Changes in α produce a tradeoff between expected return and risk of the lending when favorable soft information acquisition is considered. Since our research aims at offer a way of further increasing the economic advantage of using soft information, we are silent on the bank's choice to collect soft information versus ignoring soft information.

[15] We examine efficiency gain/loss of a regulated bank from soft information acquisition by modeling banking regulation as a capital-to-deposits ratio. However, in practice, banks undergo regulatory exams, which evaluate whether the bank is collecting sufficient information about the borrower. We would like to thank an anonymous reviewer for pointing this possibility out to us.

repayments is the promised repayments V reduced by a put option given to the borrowing firm who can sell its end-of-period asset A at a price of V.

In the context of our model, the equity of the bank can be represented as a capped call option on the value of the assets of the bank, explicitly considering the borrowing firm's risk, with the same maturity as that of the debt of the bank and with a striking price equal to the maturity value of the debt. The equity position of the bank is a hybrid position and is specified as follows:[16]

$$E = Call\,(A, Z) - Call\,(A, V) = [AN(d_1) - Ze^{-\delta}N(d_2)] - [AN(b_1) - Ve^{-\delta}N(b_2)] \tag{4}$$

where

$$\delta = R - R_D \tag{5}$$

$$d_1 = \frac{1}{\sigma + \alpha}(\ln\frac{A}{Z} + \delta + \frac{(\sigma+\alpha)^2}{2}),\quad d_2 = d_1 - (\sigma + \alpha) \tag{6}$$

$$b_1 = \frac{1}{\sigma + \alpha}(\ln\frac{A}{V} + \delta + \frac{(\sigma+\alpha)^2}{2}),\quad b_2 = b_1 - (\sigma + \alpha) \tag{7}$$

and where $N(\cdot)$ is the cumulative density function of the standard normal distribution, and δ, the difference between R and R_D, is the default-free discount rate. The first term $[\cdot]$ on the right-hand side of equation (4) can be interpreted as the value of a call on the asset A of the borrowing firm at a strike price Z. In the same way, the second term $[\cdot]$ can be interpreted as the value of a call given to the borrowing firm on the same asset at a strike price V. The second term represents the loss of value resulting from the cap. As far as bank equity risk is concerned, the final payoffs of equation (4) indicate that the variance of the bank return is given by:[17]

$$\sigma_S = \frac{\partial E}{\partial A}\frac{A}{E}\sigma = [N(d_1) - N(b_1)]\frac{A}{E}\sigma \tag{8}$$

The return and the variance of the bank's equity explicitly considering borrower soft information reveal the potentially substantial benefits and costs of relationship banking. A question that arises naturally is the extent to which soft information adds efficiency gain/loss to the bank providing the service. Given the combined positions of equations (4) and (8), we can now compare the risk/return efficiency gain from soft information acquisition. Let $SHP(WS)$ denote the ratio of excess equity return to equity standard deviation when soft information about the borrowing firm is considered ($\alpha > 0$) and let $SHP(OS)$ denote the ratio when soft information acquisition is not

[16] Equations (4) can be interpreted as the value of a call on the asset A of the borrower at an exercise price Z, net of a call given to the borrower on the same asset at an exercise price V. The term $Call\,(A,V)$ represent the loss of value resulting from the cap. We obtain the standard valuation by applying the risk neutral valuation methodology available in Black and Cox (1976).

[17] See Dermine and Lajeri (2001).

performed ($\alpha = 0$).[18] In other words,

$$SHP(WS) = \frac{E(\alpha > 0)}{\sigma_S(\alpha > 0)} \tag{9}$$

and

$$SHP(OS) = \frac{E(\alpha = 0)}{\sigma_S(\alpha = 0)} \tag{10}$$

Equations (9) and (10) can be interpreted as a conceptual excess return/risk because the opportunity-cost payments to the bank's shareholders are explicitly considered in the value of the net-obligation payments in the model. Then, the bank's efficiency gain from soft information for small business loans can be measured by the SHP differential:

$$\Delta SHP = SHP(WS) - SHP(OS) \tag{11}$$

The SHP differential measures the equity return differential, per unit of standard deviation, that accrues from holding the loan with collecting borrower soft information in lieu of ignoring borrower soft information. $\Delta SHP > 0$ is interpreted as efficiency gain from borrower soft information acquisition, whereas $\Delta SHP < 0$ is interpreted as deficiency of soft information. We can use equation (11) to study the following important question. Is soft information really efficient to an individual bank for extending small business loans?

4. Solution and results

With the specifications of equation (4), equation (8), and equation (11) in place, we are now ready to solve for the bank's optimal choice of R_L (and thus of bank interest margin) and then the comparative static results in the model. First, partially differentiating equation (4) with respect to R_L, the first-order condition is given by:

$$\begin{aligned}\frac{\partial E}{\partial R_L} = &[\frac{\partial A}{\partial R_L}N(d_1) + A\frac{\partial N(d_1)}{\partial d_1}\frac{\partial d_1}{\partial R_L} - \frac{\partial Z}{\partial R_L}e^{-\delta}N(d_2) - Ze^{-\delta}\frac{\partial N(d_2)}{\partial d_2}\frac{\partial d_2}{\partial R_L}] \\ &-[\frac{\partial A}{\partial R_L}N(b_1) + A\frac{\partial N(b_1)}{\partial b_1}\frac{\partial b_1}{\partial R_L} - \frac{\partial V}{\partial R_L}e^{-\delta}N(b_2) - Ve^{-\delta}\frac{\partial N(b_2)}{\partial b_2}\frac{\partial b_2}{\partial R_L}] = 0\end{aligned} \tag{12}$$

We require that the second-order condition be satisfied, $\partial^2 E / \partial R_L^2 < 0$. Equation (12) translates into an equilibrium condition, where the optimal loan rate is determined, such that the marginal equity value of the call on A at the strike price Z equals the marginal capped loss value on the same asset at the strike price V. Note that the optimal loan rate is determined where the marginal equity

[18] Ergungor (2005) uses a reward-to-risk ratio to measure overall bank performance where the reward is specified as time-series mean of quarterly return on assets and the risk is specified as standard deviation of quarterly return on assets. We apply Ergungor (2005) to define $SHP(WS)$ and $SHP(OS)$ in our model.

value of the call on the underlying asset V at the strike price Z if the credit risk from the capped loss is not considered. The capped loss may be from the financial soft and hard information about leverage captured by the degree of bank financing dependence. We further substitute the optimal loan rate to σ_S in equation (8) and ΔSHP in equation (11) remaining on the optimization for the comparative static analysis purposes.

Efficiency related to bank equity return and risk is a key performance issue that concerns bank managers and regulators, in particular when soft information for small business lending is taken into account. Bank efficiency gain/loss from soft information is central not only in strategic decisions made by banks, but also in decisions made by regulators concerned about banking stability. Having examined the optimal loan rate solution in our model, we next examine how borrower soft information and capital regulation affect the bank's performance (equity return, equity risk, and efficiency gain/loss), and how these effects vary across the borrowing firm's different leverages that play an important role in analyzing relationship banking. Based on equations (8) and (11) with the equilibrium condition of equation (12), we have the following two sets of comparative static results:

$$\frac{d\sigma_S}{d\alpha} = \frac{\partial \sigma_S}{\partial \alpha} + \frac{\partial \sigma_S}{\partial R_L}\frac{\partial R_L}{\partial \alpha} \tag{13}$$

$$\frac{d\Delta SHP}{d\alpha} = \frac{\partial \Delta SHP}{\partial \alpha} + \frac{\partial \Delta SHP}{\partial R_L}\frac{\partial R_L}{\partial \alpha} \tag{14}$$

$$\frac{d\sigma_S}{dq} = \frac{\partial \sigma_S}{\partial q} + \frac{\partial \sigma_S}{\partial R_L}\frac{\partial R_L}{\partial q} \tag{15}$$

$$\frac{d\Delta SHP}{dq} = \frac{\partial \Delta SHP}{\partial q} + \frac{\partial \Delta SHP}{\partial R_L}\frac{\partial R_L}{\partial q} \tag{16}$$

where

$$\frac{\partial R_L}{\partial \alpha} = -\frac{\partial^2 S}{\partial R_L \partial \alpha} \Big/ \frac{\partial^2 S}{\partial R_L^2} \tag{17}$$

$$\frac{\partial R_L}{\partial q} = -\frac{\partial^2 S}{\partial R_L \partial q} \Big/ \frac{\partial^2 S}{\partial R_L^2} \tag{18}$$

Equation (13) demonstrates the effect of the favorable soft information about the borrowing firm on the bank's equity risk evaluated at the optimal loan rate. The first term on the right-hand side of equation (13) can be identified as the direct effect, while the second term can be identified as the indirect effect. The direct effect captures the change in σ_S due to an increase in α, holding the optimal loan rate constant. The indirect effect is a sequential function of the effect of R_L on σ_S

and the effect of α on R_L. Both the direct and indirect effects give an overall response of σ_S to an increase in α. The same pattern as previously applies to equations (14) ~ (16).

In general, those effects in equations (13) ~ (16) are indeterminate since the added complexity of the capped call option valuation applied to the bank-borrowing firm situation does not always lead to clear-cut results. But, we can demonstrate reasonable parameter levels corresponding roughly to a hypothetical bank with such borrower characteristics in the next section. Toward that end, we compute several derivatives of the value function of the capped call option derived from the previous model. The numerical exercises provide intuition regarding the problems at hand in the paper.

5. Numerical analysis

According to the comparative static analysis introduced in Section 4, we can determine numerical results through a fair combination of the parameters. In this section, we mainly look at the comparative static effects of soft information and capital regulation given various parameter constellations.

5.1. Numerical specification

Unless otherwise indicated, the parameters are $R_A = 6.00\%$, $\sigma = 0.30$, $R = 3.50\%$, $R_D = 3.00\%$, and $K = 16$. Let $(R_L(\%), L)$ change from (5.20, 172) to (5.80, 109), and let α increase from 0 to 0.30. The intuition of the parameters is interpreted as follows. (i) We assume that the expected rate of return from investment A_b ($R_A = 6.00\%$) is greater than the expected rate of funding cost (R_L in our numerical analysis), that follows the argument of Dermine and Lajeri (2001). (ii) $R_L > R_D$ is limited to the positive bank interest margin, one of the principal elements of after-tax earnings (Saunders and Schumacher, 2000), and $R > R_D$ gives the binding condition of capital requirement constraint (Wong, 1997). (iii) $K / D = q = 8.00\%$ where $K = 16$ implies that the specification of capital adequacy requirement is consistent with the approach of the Basel (VanHoose, 2007). (iv) The assumption of $\sigma = 0.30$ in the numerical analysis follows the sample descriptive statistics in Episcopos (2008) where the minimum value and the maximum value of asset volatility are 0.021 and 0.314, respectively.[19] In addition, we consider three cases of the borrowing firm's leverage dependent on bank financing L / A_b, including 30%, 70%, and 90%.[20] $L / A_b = 30\%$ is specified as a low leverage case, while 90% is specified as a high one.

5.2. Soft information effect

We now examine the effect of the soft information α on the equilibrating values of the bank's loan rate R_L and of the bank's equity risk σ_S at different levels of borrower leverage. Equation (13) presented in our model will be used in the following for computing the two relevant comparative statics.

[19] To make the results more significant, we chose the volatility close to the top of the range of Episcopos' (2008) estimates. Valuing the volatility in a reasonable range does not affect the qualitative results. See also Brockman and Turtle (2003) and Dermine and Lajeri (2001).

[20] Dermine and Lajeri (2001) assume that the leverage of the borrowing firm is increased from 30% and 90% in their numerical exercises.

Table 2. Effects of favorable soft information on bank interest margin and equity risk when borrower leverage $L/A_b = 30\%$.

	$(R_L\ (\%), L)$						
α	(5.20, 172)	(5.30, 164)	(5.40, 155)	(5.50, 145)	(5.60, 134)	(5.70, 122)	(5.80, 109)
	$\partial R_L / \partial \alpha$						
0.05→0.10	-	−0.0036	−0.0002	0.0030	0.0060	0.0088	-
0.10→0.15	-	−0.0084	0.0000	0.0079	0.0153	0.0224	-
0.15→0.20	-	−0.0147	0.0007	0.0151	0.0287	0.0417	-
0.20→0.25	-	−0.0215	0.0019	0.0237	0.0442	0.0638	-
0.25→0.30	-	−0.0280	0.0033	0.0324	0.0599	0.0860	-
	$d\sigma_S / d\alpha$						
0.05→0.10	-	0.0716	0.0717	0.0718	0.0719	0.0720	-
0.10→0.15	-	0.1359	0.1361	0.1362	0.1364	0.1364	-
0.15→0.20	-	0.1936	0.1938	0.1940	0.1941	0.1942	-
0.20→0.25	-	0.2314	0.2315	0.2317	0.2318	0.2318	-
0.25→0.30	-	0.2477	0.2478	0.2479	0.2480	0.2480	-

Notes: Unless otherwise indicated, $R_A = 6.00\%$, $\sigma = 0.30$, $R = 3.50\%$, $R_D = 3.00\%$, $K = 16$, and $q = 8.00\%$. $\partial^2 S / \partial R_L^2 < 0$ confirms the required second-order condition. The optimal loan rate is approximately equal to 5.30%. The total effect, $d\sigma_S / d\alpha$, is positive since the negative indirect effect, $(\partial \sigma_S / \partial R_L)(\partial R_L / \partial \alpha)$, is insufficient to offset the positive direct effect, $\partial \sigma_S / \partial \alpha$.

In the first case reported in Table 2, we consider a borrower leverage of $L/A_b = 30\%$ where the optimal loan rate approximately equals 5.30% and show the following two results. First, the bank's small business loans are increased at a reduced interest margin when the adjustment of the favorable soft information about the borrowing firm made by the loan officer is increasingly supportive. Intuitively, as the bank has more favorable soft information about the borrowing firm, it must now provide a return based on an optimistic evaluation. One way the bank may attempt to augment its total returns is by shifting its investments to its small business loans and away from the liquid-asset market. If loan demand is relatively rate-elastic, a larger loan portfolio is possible at a reduced margin. This is consistent with the arguments of Chen et al. (2015) that soft information affects the terms of loan contracts and borrowers with better soft information enjoys lower interest rates. We suggest that such soft information is valuable to the bank for extending small business loans.

Second, our numerical result observed from the lower panel of Table 2 shows that soft information is also valuable for predicting bank equity risk for small business loans. The borrowing firm with more favorable soft information is more likely to increase the bank's equity risk. Technically, the result is understood because the negative indirect effect of α on σ_S via the

optimal R_L adjustments is insufficient to offset the positive direct effect (i.e., without the optimal R_L adjustments to give a positive net response of σ_S to an increase in α). The favorable soft information about the borrowing firm captured by the structural break α enlarges bank equity (insignificant indirect effect, marginal benefit) and risk (significant direct effect, marginal cost) simultaneously. Explicitly considering the cost and benefit of soft information acquisition for small business loans, we argue that although favorable soft information leads to the bank's extending small business loans, such information makes the bank more prone to loan risk-taking and then is not guaranteed to produce greater safety for the bank. Agarwal and Hauswald (2010) find that the subjective credit assessment of soft information for small business lending has significant ability to predict defaults of borrowers. Chen et al. (2015) also point out that the use of soft information significantly improves the power for predicting defaults of small business loans. Our result contributes to the literature that soft information is valuable for predicting bank equity risks when the bank makes small business lending decisions.

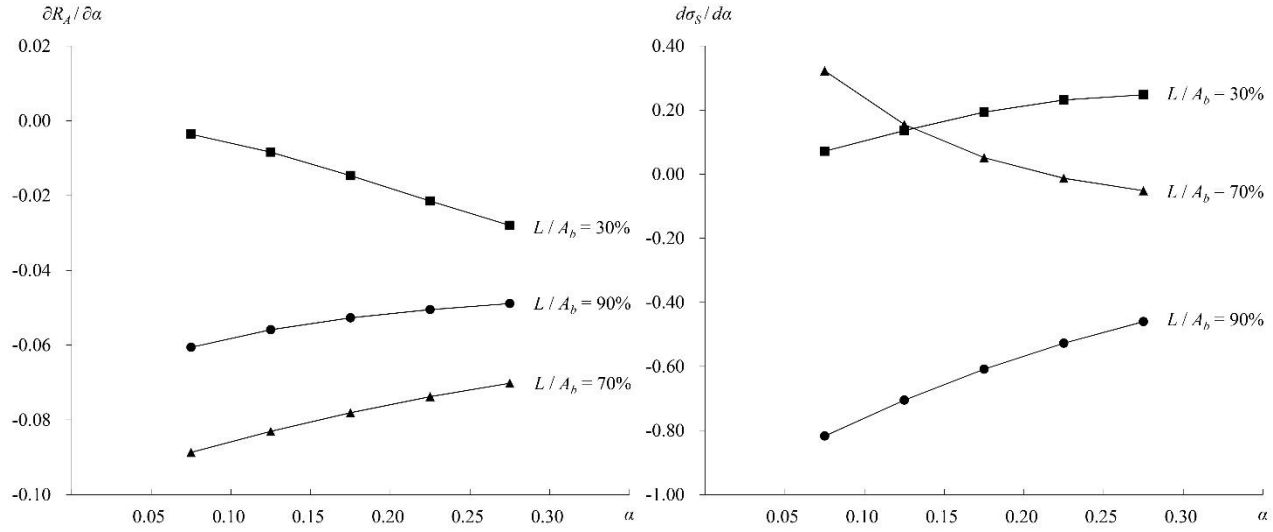

Figure 1. Effects of favorable soft information on bank interest margin and equity risk at various levels of borrower leverage. (All results are valued at the optimal loan rate of 5.30%. In the case of $L / A_b = 30\%$, the direct effect, $\partial \sigma_S / \partial \alpha$, is consistently positive in sign, and the indirect effect, $(\partial \sigma_S / \partial R_L)(\partial R_L / \partial \alpha)$, is consistently negative in sign. The direct effect is much more significant than the indirect effect. In the case of $L / A_b = 70\%$, the direct effect is positive when α is low and is negative when α is high. The indirect effect is consistently negative, but insignificant. In the case of $L / A_b = 90\%$, both the direct and indirect effects are negative in sign.)

The investigation of the soft information impacts on the optimal bank interest margin and the bank's equity risk at various levels of borrower leverage is also intriguing. Figure 1 depicts the optimal bank interest margin is a function of favorable soft information about the borrowing firm for different levels of borrower leverage. In the depiction, we find that, as the leverage increases, both the call and the capped loss are decreased, and the bank's equity value is decreased as well. This result is understood because the call is less likely to come into effect and the capped loss is less likely to vanish, as the leverage increases. As mentioned previously, an increase in favorable soft

information decreases the optimal bank interest margin. As the leverage rate increases from 30% to 70%, the negative effect of favorable soft information is increased, but the negative effect is decreased as the leverage rate increases from 70% to 90%. The former indicates that an increase in the leverage makes the bank much more prone to loan risk taking. The latter demonstrates the bank less prone to risk. The bank faces a borrower leverage dilemma due to the interaction between the call value and the capped loss captured by the negative effect of favorable soft information on the optimal bank interest margin.

Figure 1 also demonstrates the bank equity risk function as a function of favorable soft information and the optimal bank interest margin for different levels of borrower leverage. Specifically, we show that the effect of favorable soft information on bank equity risk is positive when the leverage is low, whereas the effect is negative when the leverage is high. The former has been explained previously. In the high-leverage case of $L/A_b = 90\%$, the negative direct effect explains the decreased equity risk of the bank due to an increase in the positive soft information about the firm collected by the bank, ceteris paribus. The indirect effect arises because an increase in the favorable soft information about the firm increases the bank's equity return by $L(R_L)$ in every possible state. The negative indirect effect provides us with a hunch that as favorable soft information increases, bank equity risk declines and with fat tails $(\sigma+\alpha)$ the bank is willing to take on greater risk at a reduced margin. The indirect effect reinforces the direct effect to give an overall negative response of bank equity risk to an increase in favorable soft information. Our finding suggests the possibility that the bank is willing to acquire and utilize soft information about its high-leverage borrowing firm for its small business lending decisions. In short, a contribution of our paper is that by focusing on the levels of bank financing dependence reflected by borrower leverage we can analyze the underlying that drives the acquisition of soft information for small business lending.

It is necessary to elaborate on the efficiency issue about soft information. According to equation (14), the computed results observed from Table 3 are stated in the following. We find that $\Delta SHP < 0$ when $L/A_b = 30\%$ or 70% demonstrates an efficiency loss from borrower favorable soft information acquired by the bank, whereas $\Delta SHP > 0$ when $L/A_b = 90\%$ demonstrates an efficiency gain. Our findings imply that an increase in favorable soft information about the borrowing firm increases the bank's efficiency gain when the borrower's leverage of bank financing is high. The result is explained as follows. The direct effect captures the change in ΔSHP due to an increase in α, holding the bank interest margin constant. It is unambiguously positive in sign because an increase in favorable soft information about the borrowing firm makes loans more efficient to grant. The indirect effect arises because an increase in α changes in ΔSHP by $L(R_L)$ in every possible state. The sign of the indirect effect is negative. This result is understood because an increase in favorable soft information about the borrowing firm increases the loan size at a reduced margin, as mentioned earlier, and further decreases the efficiency gain due to a reduced margin as well as an increased loan risk. The negative indirect effect is insufficient to offset the positive direct effect to give an overall positive response of ΔSHP to an increase in α. As a conclusion, we show that the bank has an increased efficiency gain by increasingly obtaining soft information if favorable one. Chen et al. (2015) argue that small business loan lenders have to rely on soft information to overcome the problems caused by the borrowers' opaque financial statements. Complementing their argument, the bank's efficiency gain from favorable soft information acquisition is increased when the borrowing firm's leverage rate is high; however, is decreased when borrower leverage is low. These results imply that favorable soft information with high leverage is important for small business lending.

Table 3. Effects of favorable soft information on bank efficiency gain from soft information for small business loans at various levels of borrower leverage.

	L / A_b		
α	30%	70%	90%
	$\Delta SHP < 0$	$\Delta SHP < 0$	$\Delta SHP > 0$
	$d\Delta SHP / d\alpha$	$d\Delta SHP / d\alpha$	$d\Delta SHP / d\alpha$
0.05→0.10	−42914	−25.0931	1.8106
0.10→0.15	−9293	−16.1752	1.7938
0.15→0.20	−3042	−11.2924	1.6723
0.20→0.25	−1289	−8.3922	1.4970
0.25→0.30	−647	−6.5692	1.2947

Notes: All results are valued at the optimal loan rate of 5.30%. In the case of $L / A_b = 30\%$, the direct effect, $\partial\Delta SHP / \partial\alpha$, is negative in sign. The indirect effect, $(\partial\Delta SHP / \partial R_L)(\partial R_L / \partial\alpha)$, is positive in sign. The positive indirect effect is insufficient to offset the negative direct effect when α is low. The positive indirect effect is sufficiently large to offset the negative direct effect. In the case of $L / A_b = 70\%$, the direct effect is negative while the indirect effect is positive. In the case of $L / A_b = 90\%$, the direct effect is positive while the indirect effect is negative. In the cases of $L / A_b = 70\%$ and 90%, the direct effect is more significant than the indirect effect.

5.3. Capital regulation effect

We start our analysis with three alternatives of borrower leverage for examining the effects of the capital-to-deposits ratio on the bank's interest margin and equity risk demonstrated in Table 4.

It is quite obvious to observe a negative effect of the capital-to-deposits ratio on the bank's interest margin, and a positive effect on the bank's equity risk. The interpretation of this result follows a similar argument as in the case of the effects of favorable soft information. When the leverage level of the borrowing firm increases, the impact on bank interest margin from capital regulation becomes much more significant. Thus, the bank becomes more loan risk prone. Further, it is interesting that, as the capital-to-deposits ratio increases, the equity risk of the bank is directly increased (the direct effect) and is decreased at a reduced margin (the indirect effect). The negative indirect effect is insufficient to offset the positive direct effect, and hence an overall response of the equity risk to an increase in the capital-to-deposits ratio is positive. We also show that the positive regulation effect is much more significant when the borrowing firm's leverage is high than that when the leverage is low.

Table 4. Effects of capital-to-deposits ratio on bank interest margin and equity risk at various levels of borrower leverage.

	L / A_b		
q (%)	30%	70%	90%
	$\partial R_L / \partial q$ (‰)	$\partial R_L / \partial q$ (‰)	$\partial R_L / \partial q$ (‰)
8.0→8.5	−0.1356	−8.5987	−16.2788
8.5→9.0	−0.1139	−7.2072	−13.6363
9.0→9.5	−0.0965	−6.1006	−11.5364
9.5→10.0	−0.0825	−5.2094	−9.8466
10.0→10.5	−0.0711	−4.4838	−8.4714
	$d\sigma_S / dq$ (‰)	$d\sigma_S / dq$	$d\sigma_S / dq$
8.0→8.5	1.1919	0.0288	0.0399
8.5→9.0	1.0607	0.0256	0.0354
9.0→9.5	0.9500	0.0229	0.0317
9.5→10.0	0.8558	0.0206	0.0285
10.0→10.5	0.7749	0.0186	0.0258

Notes: Unless otherwise indicated, $R_A = 5.20\%$, $\sigma = 0.30$, $R = 3.50\%$, $R_D = 3.00\%$, $K = 16$, and $\alpha = 0.10$. Note that the computed results of $\partial^2 S / \partial R_L^2$ at various levels of q are consistently negative in sign, which confirms the required second−order condition of equation (13) in the three alternative leverages. All results are valued at the optimal loan rate of 5.30%. In the three cases of equity risk, the direct effect is consistently positive in sign, while the indirect effect is consistently negative in sign. The indirect effect is very insignificant.

Table 5. Effects of capital-to-deposits ratio on bank efficiency gain from borrower soft information collection at various levels of borrower leverage.

	L / A_b		
q (%)	30%	70%	90%
	$\Delta SHP < 0$	$\Delta SHP < 0$	$\Delta SHP > 0$
	$d\Delta SHP / dq$	$d\Delta SHP / dq$	$d\Delta SHP / dq$
8.0→8.5	76062	11.3664	−0.3765
8.5→9.0	67352	10.0726	−0.3383
9.0→9.5	60056	8.9878	−0.3055
9.5→10.0	53884	8.0692	−0.2773
10.0→10.5	48617	7.2846	−0.2528

Notes: All results are computed based on the optimal loan rate of 5.30%. In the cases of $L / A_b = 30\%$ and 70%, both the direct and indirect effects are consistently positive in sign. In the case of $L / A_b = 90\%$, both the direct and indirect effects are negative in sign.

We also investigate the comparative static analysis behind the efficiency gain/loss of soft information for small business loans under capital regulation particularly when the various levels of borrowing firm's leverage are considered. Two results observed from Table 5 are computed based on equation (16). First, we show that the bank has an efficiency gain from favorable soft information acquisition when its borrowing firm's leverage of bank financing is high, while the bank has a deficiency when the leverage is low. Second, an increase in the capital-to-deposits ratio decreases the bank's efficiency gain from favorable soft information for small business loans. An increase in the capital-to-deposits ratio directly decreases the efficiency gain (the direct effect) and also indirectly decreases the efficiency gain at a reduced margin (the indirect effect). The indirect effect reinforces the direct effect to give an overall negative response of the efficiency gain to an increase in the capital-to-deposits ratio. As a result, we can argue that capital regulation discourages soft information acquired and produced by the bank. Bank capital is regulated by a required capital-to-deposits ratio identified as hard information about the bank. Knowing how soft information acquisition, in particular when the borrowing firm's leverage is high, is replaced by stringent capital regulation based on bank hard information is also of paramount importance for regulators contemplating prudential banking regulation. Our findings have an important policy implication. Policy makers often promote capital regulation to allegedly improve the stability of the banking sector (e.g., Kashyap et al., 2008 and Acharya et al., 2012). Our analysis suggests that there can be a proviso against this prescription. Stringent capital requirement may result in increasing bank risk-taking and the deterioration of efficiency gain from soft information acquisition by the bank in particular when borrowers heavily rely on bank financing.

6. Conclusion

By relying on a contingent claim valuation framework, the capped call option model presented in this paper tries to capture soft information for small business lending that a bank acquires. Credit risk, equity risk, borrower leverage, and structural breaks in return and volatility has been considered. An imperfectly competitive loan market assumption combined with the option pricing framework shows how the borrowing firm and the bank are intertwined. In summary, our findings suggest that there might be a bright side of borrower soft information acquisition that the bank benefits from reducing its equity risk in particular when borrowers heavily depend on banking financing. The results also show that borrowers with more favorable soft information can be offered a larger loan portfolio at a reduced margin. These findings lend support to the study of Chen et al. (2015) from new angles, for example, from the context of optimal bank interest margin determination, the perspective of soft information acquisition, and on the basis of a contingent claim theoretical model. However, capital regulation might deter the acquisition of soft information by the bank. Capital regulation as such makes the bank more prone to risk-taking and leads to deficiency gain from borrower soft information acquisition in particular when borrowers are heavily dependent on bank financing, thereby adversely affecting the stability of the banking system.

One issue that has not been addressed is relationship lending and credit quality. Is it the case that the qualitative results of this paper also apply to the relationship lending case? In a very simple rational expectation framework, the answer is expected to be positive. Specifically, since the bank and the borrower are assumed rational, soft information about the borrower may be collected by the bank based on the relationship lending. Of course, in a world without such strict rational expectation

requirements, other factors would affect soft information acquisition. For example, strategic considerations may play a very important role, as would more extreme problems of lender-borrower information asymmetries. Such concerns are beyond the scope of this paper and so are not addressed here. What this paper does demonstrate, however, is the important role played by the explicit treatment of borrower soft information in affecting bank spread behavior and the banking stability.

Acknowledgments

Shi Chen's work is supported by National Natural Science Foundation of China (No. 71603217). We would like to thank two anonymous referees for their comments and suggestions. The usual disclaimer applies.

Conflict of Interest

The authors declare no conflict of interest.

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