Article

Bank Interest Margin and Green Lending Policy under Sunflower Management

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Abstract: Sunflower management is a type of management style in which a chief executive officer (CEO) ignores information and attempts to confirm the board’s prior beliefs. The CEO’s accommodating behavior may reduce incentive conflicts but also stimulate diligent board monitoring. The present article aims to develop a contingent claim utility model to investigate the effect of green lending on bank spread behavior and board monitoring under sunflower management. The principal advantage of the contingent claim utility approach is the explicit treatment of uncertainty and diligent board monitoring, which play a prominent role in discussions of intermediary behavior. Additionally, banks may earn goodwill from a green lending policy, thus yielding environmental improvements. In this study, we explore the goodwill effect on the bank’s interest margin determination and board monitoring. We use the comparative statistics method to analyze the result of changes in the theoretical model’s exogenous parameters. Moreover, we use empirical data as a baseline for numerical simulations to explain the comparative statistics. Our main findings are that increasing green lending reduces interest margins and enforces diligent board monitoring. The increase in goodwill garnered from improvements to the bank’s green lending reputation was found to enhance the interest margins but ease active board monitoring. From these results, we outline implications such as implementing intangible goodwill asset accumulation from bank customers’ green awareness via green lending publicity that increases the bank interest margin under sunflower management, thereby affecting banking stability.

Keywords: green lending policy; bank interest margin; sunflower management; goodwill; capital regulation

1. Introduction

Chief executive officers (CEOs) behave like sunflowers, turning towards the sun and seeking nourishment for their survival. We call such behavior sunflower management [1]. Board monitoring matters because sunflower management creates a tendency for CEOs to ignore information and instead attempt to confirm their superiors’ prior beliefs [1–3]. Sunflower management may create the appearance of a family-run company, avoiding the involvement of family members in ownership and management succession [4]. Thus, given an incentive problem, a reconsideration of the agency theory deserves closer scrutiny. Additionally, green banking has become a common concern in many countries since green lending extensively uses regulatory and market methods to achieve environmental improvement goals [5,6]. Green finance literature has various focuses [7]. Our article seeks to develop a contingent claim utility model to investigate the effect of green lending on bank spread behavior and board monitoring under sunflower management.

A green lending policy is essential for sustainable development. Green lending lets banks take information related to their investments and operating firms as the inspection standard in lending and thereby make loan decisions [8]. Green lending decisions depend
on asset–liability matching management. Green lending expects the rational allocation of asset portfolios, considering loan differentiation for financial and environmental improvements [5,6]. Banks are green-finance enablers in promoting the borrowing-firm transition toward a more sustainable economy. Green finance applies to environmental, social, and governance (ESG) investing, which equals about one-fourth of the world’s investment funds, comprising about USD 20 trillion in assets. This USD 20 trillion squeezes out conventional assets, yielding higher returns than green assets [9]. Squeezed asset reallocation raises fundamental issues about agency problems, particularly from incentive conflicts that reduce expected investment returns for ESG investments [10]. Green lending, moreover, is vital to bank profitability and sustainability, particularly in an imperfectly competitive loan market. How the bank’s interest margin can be optimally determined and how it adjusts to changes in green lending policy under sunflower management are the most critical issues of the paper.

Boot et al. [1] studied sunflower management and capital budgeting by modeling a firm with a vice president overseeing analysts of varying abilities. Tsai and Lin [2] adopted the concept of sunflower management [1] to determine optimal interest margins and asset volatility under capital regulation. Lin et al. [3] examined the effects of the guaranteed rate and participation rate of life insurance policies on the insurer’s interest margin under sunflower management. However, both studies remain silent on diligent board monitoring, which is a crucial factor in sunflower management. In practice, sunflower management can capture the board’s expectations and beliefs. The board’s preferences revealed a preference for higher returns and a dislike of higher default risks [11]. In this work, we apply the methods of Tsai and Lin [2] and model a contingent claim utility function, consistent with the board utility function under sunflower management, to explore green lending influences. The advantage of this approach is the explicit treatment of uncertainty integrated with bank spread behavior under sunflower management. We further develop a diligent board monitoring function using the contingent claim utility function. In this way, we explore whether the board agrees with the green lending policy to move toward sustainable development.

This article aims to develop a contingent-claim-option framework to express a bank CEO utility function based on previous work. This utility function expresses a preference for higher equity returns and a dislike of higher default risks based on Hermalin [11]. The bank investment portfolio consists of green and conventional loans. In the sustainable lending model, the bank entitles the green borrowing firm to have a loan interest rate net of the policy interest rate in the green lending policy. Thus, the distribution of total lending of green and conventional loans under sunflower management is the bank’s green lending policy. The bank can earn some goodwill as compensation for its green lending. Goodwill is an asset accumulated by the insurer’s greening reputation. Increasing consumers’ green awareness is a market-driven factor that stimulates borrowing firms to make green improvements [12]. Thus, goodwill from green lending earns a positive reputation, accounting for an intangible asset in the insurer’s balance sheet. Accordingly, the model of green lending policy integrates the risk considerations of the portfolio–theoretical approach with the market conditions, goodwill earnings, and loan-rate-setting behavioral mode of the structure–conduct–performance approach for CEO utility maximization.

The bank’s objective is to set the optimal loan rate (i.e., the optimal interest margin between the optimal loan rate and the market deposit rate) to maximize the expected value of a contingent claim utility function. We investigate the effects of green lending policy, goodwill, board monitoring, and capital regulation on the optimal interest margin. Based on the impacts on the optimal interest margin, we further explore the issues of how the green lending policy, goodwill, and capital regulation affect board monitoring. To obtain quantitative solutions for comparative statistics, we collect empirical data from different studies and conduct a simulation exercise.

This model allows the inclusion of more realistic features. We follow Wong [13] along with the more appropriate behavioral mode of loan-rate setting in an imperfectly
competitive loan market and apply Boot et al. [1] to develop a contingent claim utility model for sunflower management. The development of the utility objective relies on Hermalin [11], considering a preference for equity returns and a dislike of volatility. We also believe that green finance induces the transition of productive firms toward a more sustainable economy. Overall, this model can apply to a more realistic situation where the CEO pleases the board when engaging in loan-rate-setting behavior and considering green lending under capital regulation.

We present the main results as follows: (i) Under sunflower management, a favorable green lending policy increases bank lending activities at a reduced interest margin. This reduced margin may be a cost of the CEO’s experience of the board’s dislike for higher equity risk. (ii) Stringent capital regulations harm bank interest margins. This result suggests that a CEO should use his or her professional ability to manage bank liquidity to increase profits when capital regulation becomes stringent. (iii) An increase in the bank’s goodwill earned from green lending enhances interest margins. The bank customers’ green awareness through green lending publicity helps the bank from the viewpoint of profitability. (iv) Diligent board monitoring clearly stimulates the CEO to increase the bank’s profits by increasing the loan-rate setting. (v) Increasing the favorable green lending policy or stringent capital regulation encourages diligent board monitoring. However, increasing the bank’s goodwill discourages active board monitoring. This study contributes to the literature showing that a favorable green lending policy might not enhance a bank’s profitability performance but still encourage diligent board monitoring. Therefore, the bank should accumulate the intangible goodwill assets earned from its green lending reputation to increase its interest margins and reduce active board monitoring under sunflower management. Goodwill, as such, makes the bank more prudent in its risk-taking by decreasing lending, thereby affecting the banking system’s stability. In conclusion, the contingent claim utility model is highly relevant to green financing with board monitoring.

The remainder of the paper is structured as follows. Section 2 presents the relevant literature as a theoretical background for modeling. Section 3 develops a contingent claim model and comparative statistics to describe the research problems. In Section 4, we outline some data collected from the relevant literature as a baseline for conducting a numerical exercise. Section 5 provides a numerical example and verifies the analysis results. Section 6 provides the discussion and implications. Lastly, we present the limitations and future research.

2. Theoretical Background

Green lending and asset–liability matching are two key management issues that concern bank CEOs and their boards. Green lending funds borrowing firms to pursue sustainable development, attracting much attention, particularly after the Paris Agreement (Accord de Paris). Asset–liability matching management is central in banks’ strategic decisions and regulators’ decisions concerning banking stability. Thus, in this study, we present five strands of related literature as a background for our modeling.

One strand is the literature on sustainable business models influencing economic and financial performance. Abid [14] focused on the link between economic and carbon performance acting through local financial intermediaries. Fernandez-Cuesta et al. [15] indicated that a higher-quality profile provides greater financial flexibility; thus, such borrowing firms have greater access to credit markets. Siddique et al. [16] demonstrated that larger-scale banking firms have a stronger tendency to provide carbon disclosures, which could benefit their carbon footprints in the longer run. Zhao et al. [17] developed a sustainable business model to evaluate the strong relationship between financial risk and greenhouse neutrality. In this study, we also developed a sustainable model, focusing on differentiating banking green/non-green lending to borrowing firms. The primary difference with our model is that we also develop a sustainable model considering sunflower management, whereas previous studies remained silent on the delegation issue.

The second strand is the asset–liability matching management literature. Punzi [18] developed a dynamic stochastic general equilibrium model to investigate bank lending
green/non-green investments. This model found that only a positive financial shock to green firms can boost production and credit. Polzin and Sanders [19] indicated the essential facilitation of green finance and highlighted significant liquidity between the demand for and supply of funds. The authors emphasized the development need for new intermediation channels to support carbon-neutral businesses. Kim et al. [20] found that countries with more concentrated banking industries may have higher carbon emissions. Bank lending to enterprises raises carbon emissions to a certain level above which more lending reduces them. Al Mamun et al. [21] found that green financing significantly reduces carbon emissions in both the short and long term. This effect is more pronounced in developed credit markets and economies with higher levels of innovation success and higher risks of climate change. Umar et al. [22] assessed the impact of carbon-neutral lending on credit portfolios and found that green loans improve bank asset quality. While we also examine asset–liability matching management, our focus on the sunflower management aspects of bank interest margin determination takes our analysis in a different direction.

The third strand is the literature on carbon emissions with operations. Hua et al. [23] developed a cap-and-trade framework to analyze the optimal order quantity of a productive firm under deterministic demand. Gong and Zhou [24] studied the impact of emission trading on firms’ production planning and found that emission allowances adversely affect the optimal base-stock level. Xu et al. [25] analyzed multiple products and price settings under the carbon cap-and-trade mechanism, focusing on the impacts of carbon trading price on production decisions and firm profits. Cao and Yu [26] studied the interface between supply chain sustainability and financing. Their study observed positive effects of carbon emission permits on financing and that manufacturers can earn higher profits by pledging carbon emission permits. Yu et al. [27] studied the economic and environmental impacts of emission trading system (ETS) applications and found that an ETS achieves a win–win scenario of carbon emission reductions and financial performance improvements. We complement this area of literature by including a carbon/non-carbon loan policy for bank interest margin determination in borrowing-firm operations. We remain silent on supply chain sustainability but focus on lender–borrower sustainability.

The fourth strand in the literature focuses on the impact of green lending on financial development. Zhang et al. [28], Nandy and Lodh [5], and Cui et al. [29] found that favorable green lending policies help banks avoid environmental risks, aid in borrowing-firm green transformation, and facilitate sustainable economic development. Wang et al. [30] and Eiler et al. [31] showed that green lending policy can improve borrowing-firm information transparency and strengthen the linkages between financial and environmental protection. Luo et al. [32] found that green credit positively impacts bank core competencies and has enhanced the competitiveness of banks with higher risks. Commercial banks can cope with green credit shock through risk control. Al-Qudah et al. [33] demonstrated that the green loan ratio hurts the NPL ratio and equity returns. Del et al. [34] found that banks with high green loan weights have lower credit and default risk and lower profitability. Yao et al. [35] studied the influence of green credit policy on firm performance from the perspective of borrowing firms. The study concluded that a green credit policy can reduce borrowing-firm performance in heavily polluting industries. Zhang and Kong [36] found that a green credit policy is not conducive to innovation in highly polluting and overcapacity industries. Our paper contributes to this field of literature by applying a green lending policy to determine bank interest margins under sunflower management.

The fifth strand is the literature on responsible lending principles. Founded in 1992, the United Nations Environment Programme Finance Initiative (UNEP FI) is a non-profit organization of the United Nations Environment Programme dedicated to the sustainable development of global financial institutions. It has developed a series of lending principles. Some research found that responsible lending principles promote the continued development of sustainable finance by advocating that banks integrate sustainability into their operations [37,38]. Gutiérrez-Nieto et al. [39] presented a credit score system for socially responsible lending. They found that ethical banks reject non-suitable applications on the
basis of a negative impact on the environment or vetted sectors such as tobacco or gambling. Goss and Roberts [40] showed that lenders are more sensitive to corporate social responsibility concerns in the absence of security. The banking sector can also benefit from taking into account the risks associated with climate change and other environmental challenges, not only helping drive the transition to low-carbon and climate-resilient economies. Cornée and Szafarz [41] found that social banks which pay attention to social and environmental criteria have better repayment performances.

3. Research Model and Problems

3.1. Conceptual Framework

The framework captures the following banking characteristics:

First, the bank provides loan contacts classified into two types of loans: conventional (carbon-emission) loans and green (carbon-emission-reduction) loans due to corporate social responsibility (CSR) (large-scale banks have a strong tendency to provide carbon disclosures (Siddique et al., 2021)). The potential benefits of providing green loans could entail both macroeconomic considerations (i.e., political and economic stability and economic growth, government commitment to stable and predictable investment incentives for low-carbon solutions, etc.) and market considerations (i.e., power purchase agreements (PPAs) incorporating protections required by international lenders, effective community engagement, etc.) (see the Climate Finance Leadership Initiative’s report (2019)). Specifically, we recognize the bank’s goodwill as a potential benefit of environmental protection lending.

Second, the conventional loan market faced by the bank is imperfectly competitive (Dai and Guo, 2020) [42], as the bank is a loan rate-setter. The bank also determines the green loan rate as the conventional loan rate net of a constant rate. The net rate depends on the bank’s green lending policy.

Third, the bank’s chief executive officer (CEO) behaves like a sunflower. The CEO looks up at the board, trying to determine what the board is thinking so that the CEO’s actions will meet the expectations and beliefs of the board. We call such behavior sunflower management [1]. In this respect, we follow Hermalin [11] and model the CEO’s sunflower behavior based on the board’s preference for higher equity returns and dislike for higher risks in equity returns. Thus, this model contributes to the green banking literature by considering sunflower management.

3.2. CEO Utility Function

The proposed model applies Tsai and Lin [2] to demonstrate the CEO’s utility function by combining a contingent claim pricing of bank equity and bank default risk in the form of a sunflower management style. First, we develop a model to evaluate the bank’s equity. At the beginning of the period, the bank has the following balance sheet (Punzi [18] modeled the bank’s balance sheet as Equation (1) but remained silent on goodwill assets):

\[ L + L_C + G + B = D + K = K(1/q + 1) \]  

where \( L = \) conventional loans, \( L_C = \) green loans, \( G = \) goodwill, \( B = \) liquid assets, \( D = \) deposits, \( K = \) equity capital, and \( q = \) capital-to-deposits ratio.

The bank provides conventional loans that mature at the end of the period. The repayments are \((1 + R_L)L\), where the bank determines the conventional loan rate \((R_L)\). The determination indicates the demand function for the conventional loans \((L(R_L))\) with a downward-sloping feature \(\frac{\partial L}{\partial R_L} < 0\). Similarly, the repayments from the green loans are \((1 + (R_C - x))L_C = (1 + R_C)L_C\). Here, \(R_C\) is the green loan rate. The positive difference between the conventional loan rate and the constant interest rate \((x)\) explains the bank’s green lending policy for contributing to environmental protection. The intangible goodwill assets \((G)\) are obtained from the bank’s reputation for environmental protection. A significant contribution to environmental protection may make goodwill increase. Decreased goodwill may indicate goodwill impairment/derogation. The bank also earns liquid-asset investments \((1 + R)B\), where the rate \((R)\) is the security market interest rate. In addition
to assets, the deposit payments are \((1 + R_D)D\), where \(R_D\) is the deposit market rate. Here, we use the capital-to-deposits ratio \(q\) to express risk-based capital regulation.

We extend Merton [43] to the case of carbon banking. This model views the bank’s equity value as a call option on the bank’s assets. The underlying assets \((V_C)\) of the call follow a geometric Brownian motion:

\[
dV_C / V_C = \mu dt + \sigma dW
\]

where

\[
V_C = (1 + R_L)X + (1 + (R_L - \alpha))L + \alpha G
\]

and where \(\mu = \text{an instantaneous drift, } \sigma = \text{instantaneous volatility, } W = \text{a standard Wiener process, } \alpha > 1 = \text{goodwill from environmental protection contributions, and }\alpha < 1 = \text{goodwill impairments.}

In Equation (2), the underlying asset portfolio consists of convention loan repayments, repayments from green loans, and goodwill. The portfolio composition indicates conventional/green lending subject to non-performance. Additionally, the strike price \((X_C)\) of the call is the book value of the net liabilities specified as

\[
X_C = (1 + R_D)K/q - (1 + R)[K(1/q + 1) - (L + LC + G)]
\]

The net obligations include the payments to depositors net of the liquid-asset investment returns.

The market value of the bank’s equity returns can be a call option:

\[
S = \text{Max}[0, V_C - X_C] = V_CN(d_1) - X_Ce^{-R}N(d_1 - \sigma) \quad (3)
\]

where

\[
d_1 = \frac{1}{\sigma} \left( \ln \frac{V_C}{X_C} + R + \frac{\sigma^2}{2} \right)
\]

and \(N(\cdot)\) = the cumulative density function of the standard normal distribution.

Equation (3) describes how the bank’s equity holders are the residual claimants on the borrowing-firm investment returns covering all other net obligations. If the borrowing-firm investment returns are insufficient to cover the net obligations, the bank’s equity value is zero.

Using the information from Equation (3), following Vassalou and Xing [44], we write the default risk in the bank’s equity returns. The default risk \((DR)\) is the default probability that the bank’s investment returns from its lending will be less than its net-obligation payments, as follows:

\[
DR = \text{Probability } (V_{C,1} \leq X_C, \text{ given } V_C) = \text{ Probability } (\ln V_{C,1} \leq \ln X_C, \text{ given } V_C).
\]

Since the underlying assets follow geometric Brownian motion, the value of the assets during the period is

\[
\ln V_{C,1} = \ln V_C + (\mu - \frac{\sigma^2}{2}) + \sigma \epsilon_{0+1}
\]

where \(\epsilon_{0+1} = (W(0 + 1) - W(0)) \sim N(0,1).

Therefore, we can rewrite \(DR\) as follows:

\[
DR = \text{ Probability } (\ln V_C - \ln X_C + (\mu - \frac{\sigma^2}{2}) + \sigma \epsilon_{0+1} \leq 0) = \text{ Probability } (-\frac{1}{\sigma} \left( \ln \frac{V_C}{X_C} + (\mu - \frac{\sigma^2}{2}) \right) \geq \epsilon_{0+1}).
\]

We then obtain the distance to default as follows:

\[
d_2 = \frac{1}{\sigma} \left( \ln \frac{V_C}{X_C} + \mu - \frac{\sigma^2}{2} \right).
\]

The distance to default \((d_2)\) represents how many standard deviations the term \((\ln(V_C/X_C))\) needs to deviate from its mean for a default to occur. We further apply Merton’s (1974) [43] model to obtain the following theoretical probability of default:

\[
DR = N(-d_2).
\]

Sunflower management describes a management style adopted by CEOs to produce a consensus between their views and the board. Thus, the CEO’s utility function may be
equivalent to the board’s. Under this background, we apply Hermalin [11] and formulate the CEO’s utility function as an additively separable utility function as follows:

$$U(S, DR) = \delta S + (1 - \delta)(-DR)$$ \hspace{1cm} (5)

The first term on the right-hand side in Equation (5) identifies the preference (utility) of high returns and the dislike (disutility) of high default risk. The weighted preference parameters ($0 < \delta < 1$, and $1 - \delta$) are for utility and disutility, respectively. Hermalin [11] defines the ratio ($\phi = \frac{\delta}{(1 - \delta)}$) as an indicator of the board’s diligent monitoring. This ratio implies that the board diligently monitors the CEO due to a preference for high returns. The CEO is proactive in the board’s diligence under sunflower management.

3.3. Optimal Loan Rate and Comparative Statistics

The first-order condition for the CEO’s utility maximization is

$$\frac{\partial U}{\partial R_L} = \delta \frac{\partial S}{\partial R_L} - (1 - \delta) \frac{\partial DR}{\partial R_L} = 0$$ \hspace{1cm} (6)

where

$$\frac{\partial S}{\partial R_L} = V_C \frac{\partial N(d_1)}{\partial d_1} \frac{\partial d_1}{\partial R_L} - X_C e^{-R} N(d_1 - \sigma_C) \frac{\partial (d_1 - \sigma_C)}{\partial R_L}$$

$$\frac{\partial DR}{\partial R_L} = -\frac{\partial N(d_2)}{\partial d_2} \frac{\partial d_2}{\partial R_L}.$$

Equation (6) determines the optimal loan rate for the CEO’s utility maximization. The sufficient condition for the optimum implies a possibility that the utility function is strictly concave ($\frac{\partial^2 U}{\partial R_L^2} < 0$), at least in the short term. Determining the optimal loan rate can also determine the optimal bank interest margin—i.e., the spread between the optimal loan rate and the market-determined deposit rate. The bank interest margin is a vital indicator of financial intermediation efficiency [13].

Next, we consider the effects of changes to parameter $i$ ($= x, G, \delta$, and $q$) on the optimal loan rate (and thus the optimal interest margin). The implicit differentiation of Equation (6) with parameter $i$ yields

$$\frac{\partial R_L}{\partial i} = -\frac{\partial^2 U}{\partial R_L \partial i} / \frac{\partial^2 U}{\partial R_L^2}.$$ \hspace{1cm} (7)

We also examine the effects of preferences for high returns $\delta$ to changes in goodwill and the capital-to-deposit ratio ($j = x, G$, and $q$, respectively):

$$\frac{\partial \delta}{\partial j} = -\frac{\partial R_L}{\partial j} \frac{\partial R_L}{\partial \delta}.$$ \hspace{1cm} (8)

In the following section, we use numerical analyses to interpret the comparative statistics. Numerical exercises are essential because the comparative statistical results in sunflower management are policy-initiated under strategic asset–liability matching management.

4. Data and Methodology

Simulation allows one to explore what-if questions and scenarios without experimenting on the system itself. This approach helps identify bottlenecks in information. Before proceeding with the simulation based on the comparative statistics derived from the model, we collected some data based on empirical studies. These data enable the inclusion of more realistic markets. Unless otherwise indicated, we assume the numerical values used in the model as follows:

(i) According to the report by Trading Economics, from 2013~2021 in China, the highest bank loan rate was 5.77%, and the lowest one was 3.85% (https://tradingeconomics.com/china/interest-rate, accessed on 20 April 2022). Thus, we assume the downward-sloping demand curve as follows: (4.90, 190), (5.00, 185), (5.10, 179), (5.20, 172), (5.30, 164), (5.40, 155), (5.50, 145).
(ii) We believe the condition $R < R_C < R_L$ to be valid in our model. The carbon loan rate is greater than the liquid-asset interest rate (such as the bond interest rate) since the carbon loan rate is subject to non-performance. The conventional loan rate is greater than the carbon loan rate since the bank is willing to participate in trend-initiated carbon solutions to earn its goodwill for banking operations [44,45]. In China, the bond interest rate was 2.52% on April 30 in 2020 but 3.20% on the same day in 2021. For simplicity, we assume that $R = 2.86\% = (2.52\% + 3.20\%) / 2$ (https://tradingeconomics.com/china/government-bond-yield, accessed on 20 July 2022). The carbon interest rate ($R_C$) equals the difference rate ($R_L - x$), where the rate ($x$) can be a carbon solution. Qualified borrowing firms can more easily obtain bank carbon loans based on the bank’s carbon lending policy. The upper limit of rate $x$ is the difference between $R_L$ and $R = 2.86\%$. Here, we use the ease of doing business rating to evaluate rate $x$. The rank of China improved from 99 in 2012 to 31 in 2019 (https://tradingeconomics.com/china/ease-of-doing-business, accessed on 20 December 2019). We assume that a decrease in rank by 10 points would make the bank reduce its carbon loan rate by 0.10%. The average decrease in rank from 2012 to 2019 was 34 (=99 – 33). Thus, we assume that $x = 0.34\%$. The rank for ease of doing business as a criterion of the bank’s carbon lending policy captures the spirit of ease of lending attraction in the carbon market.

(iii) In a cost–benefit analysis, we assume that the minimum benefit level of goodwill due to the bank’s carbon lending policy for environmental protection is $((R_L - R_C)L_C)$. This assumption implies that environmental protection yields goodwill. Here, we assume a conventional loan bundle at $(R_L(%),L) = (4.90, 190)$ and that $R_C = R_L - x = 4.90\% - 0.34\% = 4.56\%$. For simplicity, we also assume that the carbon loans are equal to 190. Thus, the goodwill asset equals $0.34\% \times 190 = 0.646$. The computed results emerge from the bundle assumptions of $(R_L(%),L) = (4.90, 190)$. However, our comparative statistical results could be different under different initial bundles.

(iv) Wang and Wu [46] showed that banks charge a higher loan spread to borrowers with more significant direct carbon emissions compared to those with indirect emissions. This effect increases when lenders are more committed to combating global warming. Accordingly, we assume that $\alpha = 1.20$, which reflects the bank’s goodwill from environmental protection contributions.

(v) According to the report by Trading Economics, from 1990~2021 in China, the highest bank deposit rate was 3.15%, and the lowest was 0.35% (https://tradingeconomics.com/china/deposit-interest-rate, accessed on 10 July 2022). Thus, we assume that $R_D = 1.75\%$.


(vii) We assume an initial preference degree equal to $\delta = 0.50$. A value of $\delta > 0.5$ reveals that the CEO has a high-return preference, while a value of $\delta < 0.5$ indicates that the CEO has a high-risk-dislike preference.

(viii) Tan and Floros [47] studied stock market volatility and bank performance in China. Here, we use their data descriptions and assume instantaneous drift of $\mu = 0.15$ and instantaneous volatility of $\sigma = 0.09$. Table 1 summarizes the data descriptions.

<table>
<thead>
<tr>
<th>Table 1. Initial data descriptions for the numerical analyses.</th>
</tr>
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<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>----------------</td>
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<tr>
<td>$R$: liquid-asset interest rate</td>
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</tbody>
</table>
Table 1. Cont.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Approximations and Assumptions</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x$: carbon lending policy</td>
<td>0.34%</td>
<td>Trading Economics (2012–2019)</td>
</tr>
<tr>
<td>$R_D$: deposit interest rate</td>
<td>1.75%</td>
<td>Trading Economics (1990–2021)</td>
</tr>
<tr>
<td>$q$: capital-to-deposit ratio</td>
<td>11.55%</td>
<td>CEIC Data (2007–2020)</td>
</tr>
<tr>
<td>($R_C$ ($%$), $L_C$): carbon loan bundle</td>
<td>(4.56, 190)</td>
<td>Wang and Wu [46]</td>
</tr>
<tr>
<td>$G$: goodwill assets</td>
<td>0.646</td>
<td>Wang and Wu [46]</td>
</tr>
<tr>
<td>$\alpha$: environmental protection contribution</td>
<td>1.2</td>
<td>Wang and Wu [46]</td>
</tr>
<tr>
<td>$\delta$: preference degree</td>
<td>0.5</td>
<td>Hermalin [11]</td>
</tr>
<tr>
<td>$\mu$: instantaneous drift</td>
<td>0.15</td>
<td>Tan and Floros [47]</td>
</tr>
<tr>
<td>$\sigma_C$: instantaneous volatility</td>
<td>0.09</td>
<td>Tan and Floros [47]</td>
</tr>
</tbody>
</table>

5. Results

In the following section, we present two sets of results based on Equations (7) and (8).

5.1. Effects on Bank Interest Margins

Here, we elaborate on the impacts of the bank’s green lending policy, goodwill, board monitoring, and capital regulation on the bank’s interest margins.

Table 2 outlines the results when the bank increases its conventional loans at a reduced loan rate and implements a more favorable green lending policy. Here, green lending increases as the bank decides to implement a more favorable green lending policy. This increased green lending makes the bank shift its investments to conventional loans and away from liquid assets since its investments are at a lower level of green loans. The bank attempts to increase its investment returns by increasing conventional loans at a reduced loan rate. This case shows that conventional and green loans are complementary under green lending policy, which reduces the bank’s interest margins. Thus, environmental protection decreases the bank’s profitability, indicating a “penalty effect” on bank performance despite improving the bank’s goodwill from environmental protection. Yao et al. [35] suggest that a green lending policy reduces firm performance in heavily polluting industries. Our results are implicitly consistent with the results for conventional loans lent to heavily polluting firms. The bank’s goodwill comes from its low-carbon-emission lending involvement. Table 3 demonstrates that an increase in goodwill decreases conventional loans at an increased loan rate (and thus at an increased margin) for board utility maximization. Goodwill decreases the bank’s carbon loans since an increased loan rate implies a less favorable carbon lending policy whose cost savings increase the bank’s profits. The higher the conventional loan rate (i.e., the higher the interest margins), the lower the carbon-emission rate. Bank goodwill is an important element for efficient asset–liability matching management. Our findings also agree with Fernandez-Cuesta et al. [15], who showed that low-carbon-emission borrowing firms have more significant access to credit markets. Thus, profit-maximization-oriented shareholders might react favorably toward the CEO’s sunflower behavior.

Table 2. Effect of green lending policy on the bank’s interest margins.

<table>
<thead>
<tr>
<th>$(R_C$ ($%$), $L_C$)</th>
<th>4.90, 190</th>
<th>5.00, 185</th>
<th>5.10, 179</th>
<th>5.20, 172</th>
<th>5.30, 164</th>
<th>5.40, 155</th>
<th>5.50, 145</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x$ (%)</td>
<td>0.34</td>
<td>18.7207</td>
<td>18.7223</td>
<td>18.6882</td>
<td>18.6175</td>
<td>18.5090</td>
<td>18.3618</td>
</tr>
<tr>
<td></td>
<td>0.36</td>
<td>18.7044</td>
<td>18.7059</td>
<td>18.6718</td>
<td>18.6010</td>
<td>18.4924</td>
<td>18.3451</td>
</tr>
<tr>
<td></td>
<td>0.38</td>
<td>18.6882</td>
<td>18.6896</td>
<td>18.6554</td>
<td>18.5845</td>
<td>18.4759</td>
<td>18.3285</td>
</tr>
</tbody>
</table>
Table 2. Cont.

<table>
<thead>
<tr>
<th>(x(%))</th>
<th>((R_L\ (%)), (L))</th>
<th>((5.00, 185))</th>
<th>((5.10, 179))</th>
<th>((5.20, 172))</th>
<th>((5.30, 164))</th>
<th>((5.40, 155))</th>
<th>((5.50, 145))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40</td>
<td>18.6719</td>
<td>18.6733</td>
<td>18.6390</td>
<td>18.5680</td>
<td>18.4593</td>
<td>18.3118</td>
<td>18.1246</td>
</tr>
<tr>
<td>0.42</td>
<td>18.6557</td>
<td>18.6570</td>
<td>18.6227</td>
<td>18.5516</td>
<td>18.4427</td>
<td>18.2952</td>
<td>18.1079</td>
</tr>
<tr>
<td>0.44</td>
<td>18.6395</td>
<td>18.6407</td>
<td>18.6063</td>
<td>18.5351</td>
<td>18.4262</td>
<td>18.2785</td>
<td>18.0911</td>
</tr>
<tr>
<td>0.46</td>
<td>18.6233</td>
<td>18.6244</td>
<td>18.5899</td>
<td>18.5187</td>
<td>18.4096</td>
<td>18.2619</td>
<td>18.0744</td>
</tr>
</tbody>
</table>

\[ \partial R_L / \partial x \]

0.34 \rightarrow 0.36 - -1.0233 -1.0627 -1.1034 -1.1462 -1.1923 -
0.36 \rightarrow 0.38 - -1.0235 -1.0629 -1.1034 -1.1462 -1.1922 -
0.38 \rightarrow 0.40 - -1.0237 -1.0630 -1.1035 -1.1462 -1.1922 -
0.40 \rightarrow 0.42 - -1.0239 -1.0632 -1.1036 -1.1462 -1.1922 -
0.42 \rightarrow 0.44 - -1.0242 -1.0633 -1.1037 -1.1462 -1.1921 -
0.44 \rightarrow 0.46 - -1.0244 -1.0635 -1.1037 -1.1462 -1.1921 -

Note: Parameter values, unless stated otherwise: \(R_L = 2.86\%\), \(R_D = 1.75\%\), \(L_C = 190\), \(K = 15\), \(q = 11.55\%\), \(G = 0.646\), \(\alpha = 1.20\), \(\mu = 0.15\), and \(\sigma_C = 0.09\). The second-order condition was consistently confirmed. The shaded areas represent the values evaluated at the optimal loan rate (4.90%).

Table 3. Effects of goodwill on the bank’s interest margins.

<table>
<thead>
<tr>
<th>(G)</th>
<th>((R_L\ (%)), (L))</th>
<th>((5.00, 185))</th>
<th>((5.10, 179))</th>
<th>((5.20, 172))</th>
<th>((5.30, 164))</th>
<th>((5.40, 155))</th>
<th>((5.50, 145))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.646</td>
<td>18.7207</td>
<td>18.7223</td>
<td>18.6882</td>
<td>18.6175</td>
<td>18.5090</td>
<td>18.3618</td>
<td>18.1749</td>
</tr>
<tr>
<td>0.746</td>
<td>18.7303</td>
<td>18.7319</td>
<td>18.6979</td>
<td>18.6272</td>
<td>18.5187</td>
<td>18.3715</td>
<td>18.1847</td>
</tr>
<tr>
<td>0.846</td>
<td>18.7399</td>
<td>18.7416</td>
<td>18.7076</td>
<td>18.6369</td>
<td>18.5284</td>
<td>18.3813</td>
<td>18.1945</td>
</tr>
<tr>
<td>0.946</td>
<td>18.7496</td>
<td>18.7513</td>
<td>18.7173</td>
<td>18.6466</td>
<td>18.5382</td>
<td>18.3910</td>
<td>18.2042</td>
</tr>
<tr>
<td>1.146</td>
<td>18.7689</td>
<td>18.7706</td>
<td>18.7366</td>
<td>18.6660</td>
<td>18.5576</td>
<td>18.4106</td>
<td>18.2238</td>
</tr>
<tr>
<td>1.246</td>
<td>18.7785</td>
<td>18.7802</td>
<td>18.7463</td>
<td>18.6757</td>
<td>18.5674</td>
<td>18.4203</td>
<td>18.2336</td>
</tr>
</tbody>
</table>

\[ \partial R_L / \partial G (10^{-1}) \]

0.646 \rightarrow 0.746 - 0.5604 0.5722 0.5830 0.5930 0.6025 -
0.746 \rightarrow 0.846 - 0.5600 0.5719 0.5826 0.5927 0.6021 -
0.846 \rightarrow 0.946 - 0.5597 0.5715 0.5823 0.5923 0.6018 -
0.946 \rightarrow 1.046 - 0.5593 0.5712 0.5819 0.5919 0.6014 -
1.046 \rightarrow 1.146 - 0.5590 0.5708 0.5816 0.5916 0.6011 -
1.146 \rightarrow 1.246 - 0.5586 0.5705 0.5812 0.5912 0.6007 -

Note: Parameter values, unless stated otherwise: \(R_L = 2.86\%\), \(R_D = 1.75\%\), \(L_C = 190\), \(K = 15\), \(q = 11.55\%\), \(G = 0.646\), \(\alpha = 1.20\), \(\mu = 0.15\), and \(\sigma_C = 0.09\). The second-order condition was consistently confirmed. The shaded areas represent the values evaluated at the optimal loan rate (4.90%).

Next, we focus on the robustness test. Table 4 shows that the positive effect of goodwill on bank interest margins consistently increases as the capital-to-deposit ratio increases. Thus, the robustness is valid. Stringent capital regulation stimulates the goodwill effect on increasing bank interest margins (and thus bank profitability performance) since capital regulation reduces conventional loans at an increased loan rate. Zhou et al. [48] found that corporate social responsibility can positively impact bank financial performance in the long term. Our results can help further explain the findings of Zhou et al. [48]. Bank goodwill is acquired through green lending due to environmental protection considerations. This goodwill is, in general, not a short-term issue. In addition, capital regulation generally aims at reducing conventional lending, thereby keeping loan rates constant to ensure banking stability. Thus, we suggest that stringent capital regulation stimulates goodwill’s effects on increasing bank profitability performance in the long term, which overall supports the results of Zhou et al. [48].
Table 4. Effects of goodwill on the bank’s interest margins at variable levels of capital regulation.

<table>
<thead>
<tr>
<th>$G$</th>
<th>$q = 0.0855$</th>
<th>$q = 0.0955$</th>
<th>$q = 0.1055$</th>
<th>$q = 0.1155$</th>
<th>$q = 0.1255$</th>
<th>$q = 0.1355$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\partial R_L / \partial G$ ($10^{-3}$)</td>
<td>0.5513</td>
<td>0.5550</td>
<td>0.5580</td>
<td>0.5604</td>
<td>0.5624</td>
<td>0.5641</td>
</tr>
<tr>
<td>0.646 → 0.746</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.746 → 0.846</td>
<td>0.5510</td>
<td>0.5547</td>
<td>0.5576</td>
<td>0.5600</td>
<td>0.5621</td>
<td>0.5638</td>
</tr>
<tr>
<td>0.846 → 0.946</td>
<td>0.5506</td>
<td>0.5543</td>
<td>0.5573</td>
<td>0.5597</td>
<td>0.5617</td>
<td>0.5634</td>
</tr>
<tr>
<td>0.946 → 1.046</td>
<td>0.5503</td>
<td>0.5540</td>
<td>0.5569</td>
<td>0.5593</td>
<td>0.5614</td>
<td>0.5631</td>
</tr>
<tr>
<td>1.046 → 1.146</td>
<td>0.5499</td>
<td>0.5536</td>
<td>0.5566</td>
<td>0.5590</td>
<td>0.5610</td>
<td>0.5627</td>
</tr>
<tr>
<td>1.146 → 1.246</td>
<td>0.5496</td>
<td>0.5533</td>
<td>0.5562</td>
<td>0.5586</td>
<td>0.5607</td>
<td>0.5624</td>
</tr>
</tbody>
</table>

Note: Parameter values, unless stated otherwise: $R = 2.86\%$, $R_D = 1.75\%$, $L_C = 190$, $K = 15$, $R_C = 4.56\%$, $x = 0.34\%$, $\delta = 0.50$, $\alpha = 1.20$, $\mu = 0.15$, and $\sigma_C = 0.09$. The second-order condition was consistently confirmed. The shaded areas represent the values evaluated at the optimal loan rate.

Table 5 shows that increasing the capital-to-deposits ratio increases conventional loans at a reduced loan rate (a reduced margin). As the regulator forces the bank to increase its capital holdings relative to its deposits, the bank must provide returns to a larger capital base. Under these circumstances, the bank could increase its total revenues by shifting from liquid assets to conventional and carbon loans at a reduced margin under sunflower management. Bank capital regulation increases conventional and carbon-emission-reduction loans. However, capital regulation also makes a bank more prone to risk-taking, adversely affecting the bank’s profitability and stability. Accordingly, one could argue that bank interest margin management under CEO sunflower behavior harms bank profitability and enhances banking instability. However, carbon-emission-reduction loans are increased by stringent capital regulation.
The results outlined in Tables 2–6 are used in this section to further explore three comparative statistics related to the effects on board monitoring based on Equation (8). First, we explain the results of the term \(\partial R_L / \partial x\) = \(\partial R_L / \partial x\) \(\partial R_L / \partial \delta\). As mentioned previously, the numerator indicates that an increase in favorable green lending policy decreases the bank’s interest margin. The denominator indicates that an increase in board monitoring increases the bank’s interest margins. Hence, we conclude that an increase in favorable green lending policy stimulates board monitoring under sunflower management. This result is understandable because a favorable green lending policy also encourages conventional lending at a reduced margin. Reduced profitability performance enhances the need for board monitoring to achieve utility maximization.

Second, we investigate the impact of the bank’s goodwill on board monitoring based on Equation (8), where \(j = G\). The term \(\partial R_L / \partial G\) is a positive effect observed in Table 4. The term \(\partial R_L / \partial G\) is also a positive effect shown in Table 5. From these terms, we obtain \(\partial \delta / \partial G < 0\), indicating that increasing the bank’s goodwill decreases the board’s monitoring of high-return preferences. Increases in the bank’s goodwill due to environmental protection lending also reduce board monitoring. This result indicates that the board and the CEO are concerned about achieving environmental protection through lending to carbon-emission-reduction borrowing firms. This result highlights the importance of sunflower management in bank interest margin management.

Third, we examine the impact of the capital-to-deposits ratio on board monitoring based on Equation (8), where \(j = q\). The term \(\partial R_L / \partial q\) is a positive effect shown in Table 5, while \(\partial R_L / \partial q\) is a negative effect shown in Table 6. From these terms, we obtain \(\partial \delta / \partial q > 0\), where stringent capital regulation encourages the board to monitor the CEO diligently. When the bank is forced to increase its capital relative to its deposits, the bank must provide returns to a larger capital base. Enforcement involves the regulator monitoring the bank. Under these circumstances, the board may attempt to augment its total returns by enhancing its own monitoring. Thus, under this situation, the bank is double-monitored by both the regulator and the board, significantly increasing total lending at greatly reduced interest margins and adversely affecting banking stability.
6. Discussion and Implications

The CEO and the board could conflict with incentives since the CEO has a substantial amount of knowledge capital invested in the bank. Sunflower management might avoid new conflicts while ignoring the CEO’s knowledge capital and pleasing the board [1]. In this study, we focused on the green lending policy under sunflower management. One finding is that when the CEO conducts green lending, he or she decreases the bank’s interest margins and creates banking instability. Under these circumstances, the board might increase its monitoring to increase margins, keeping green lending constant. Increases in green lending could make the board more diligent in monitoring. One implication is that the board could support the CEO’s green lending policy without causing incentive conflicts under sunflower management.

The increased goodwill earned from a green lending reputation might compensate for reduced margins and contribute to banking stability. For this reason, bank green lending is essential for sustainable improvement. More importantly, by publicly inducing customer awareness, green lending is crucial for utility maximization. Additionally, stringent capital regulation would deteriorate the bank’s interest margins and create banking instability. Under these circumstances, board monitoring would become more diligent, increasing bank margins and banking stability. Even if the CEO ignores his or her information and instead attempts to confirm the board’s beliefs, the board could help when the regulator implements stringent capital regulations in the banking system. Therefore, we suggest that sunflower management with board diligence could contribute to bank profitability and stability when considering green lending policies.

7. Limitations and Future Research

In this work, we developed a contingent claim utility model to demonstrate sunflower management. The derived comparative statistical results were then used as the basis for the numerical simulation. Thus, the data used for the simulation are very critical. One limitation is that using empirical data from a specific bank for the simulation would have been ideal. Instead, we used empirical data from different studies due to the difficulties in collecting data from one particular bank. The second limitation is the imperfectly competitive loan market used in model development, where the bank is a loan-rate setter. Additionally, the results derived from the model might not extend to cases where the bank is a loan-rate taker.

One caveat is that our analysis focused only on a sunflower management issue and did not deal with the many other essential areas of organizational management. For example, we did not explore information asymmetry between the CEO and the board under sunflower management or the separation of control from ownership. While there are significant issues in this approach, they can be best understood when analyzing conflicts of incentives in green lending. By focusing on the green lending policy under sunflower management, we established the importance of the organizational management structure in bank lending.

The model presented here is general and opens at least one further avenue of research. For example, the model could accommodate the capped risks from borrowing firms to analyze green lending efficiency under board monitoring. Whether or not the board supports green lending policies could then be investigated.


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References


