Strategic Balance Sheet Management

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Bank, Bilanzstrukturmanagement, Asset and Liability Management, Duration, Fristentransformation, Portfoliomanagement, Risikomanagement, Zinsänderungsrisiko

Banking, Strategic Balance Sheet Management, Asset and Liability Management, Duration, Term Transformation, Portfolio Management, Risk Management, Interest Rate Exposure

Die Übernahme des Risikos aus der Transformation von liquiden Kundeneinlagen in langfristige Kredite und Hypotheken ist eine wichtige Ertragsquelle Schweizerischer Kantonal- und Regionalbanken. In monatlichen Steuerungsausschüssen berät das Management über die aktuelle Risikosituation der Bank und fällt Entscheide über strategische Massnahmen, wie die Konditionenpolitik oder den Einsatz von Zinsderivaten, um das Risikoprofil und die Liquiditätssituation der Bank aktiv zu steuern. Dieses aktive Management ist bekannt als «Strategic Balance Sheet Management» (BSM). Die vorliegende Arbeit trägt in zwei Bereichen zur bestehenden Literatur bei: Zuerst schlagen wir eine Kategorisierung von BSM Strategien anhand zweier grundlegender Fragen der Finanzierungstheorie vor. In einem zweiten Schritt führen wir eine vergleichende Performance Analyse der betrachteten BSM Strategien durch. Unsere Forschungsmethodik ist eine Simulation auf Basis historischer Zinssätze und realer Aktiva und Passiva einer Schweizerischen Kantonalbank, welche repräsentativ für eine Reihe mittelgrosser Kommerzbanken ist. Unsere Resultate sprechen für eine «leveraged passive» BSM Strategie, d.h. eine Bilanzstruktur mit einem kurzfristigen Passivüberhang. Eine aktive BSM Strategie macht nur dann Sinn, wenn eine Bank in der Lage ist, die Zinsentwicklung präziser vorherzusehen als der Kapitalmarkt.

The profit from transforming liquid customer deposits into long-term loans and mortgages is an important source of earnings for financial institutions, in particular for banks. In monthly steering committee meetings, management reviews the bank's current risk exposure and decides on measures, such as the pricing of loans and the use of interest rate derivatives to actively adapt its risk exposure and liquidity profile to its strategic objectives. This kind of active management is known as «Strategic Balance Sheet Management» (BSM). This paper makes two significant contributions to the existing literature: First, we propose a categorization of strategies in BSM based on two fundamental questions in financial theory. Secondly, we perform a comparative performance analysis of the proposed classes of BSM strategies. Our methodology is a simulation based on historical interest rates and real assets and liabilities of a Swiss *cantonal bank, which we regard representative of a broad class of mid-sized commercial banks. Our results strongly support a «leveraged passive» BSM strategy, i.e. a balance sheet with a short-term liability overhang. Besides, an active BSM strategy is a viable option, if financial institutions possess superior capabilities to forecast interest rates.*

1 Introduction

In benign capital market conditions, many financial institutions are satisfied with keeping their risk exposures within regulatory limits. However, when funding conditions become difficult and regulatory scrutiny increases, the importance of a holistic view on balance sheet risk exposures increases. This situation as well as advances in simulation techniques encourage the research of systematic and quantitatively founded strategies in Balance Sheet Management (BSM).

The framework of BSM refers to decisions related to the risk/return profile of a balance sheet. Decisions can be taken on the commercial as well as the financial side of business. Commercial BSM refers to product pricing and structuring as well as the selective growth or divestment of business lines. Financial BSM involves decisions on the debt/equity structure and the use of certain financial derivatives. As the commercial side of business is subject to multiple interactions between different stakeholders, it is difficult to control in a stringent and quantitative manner. In contrast, the financial side of business allows for the development of systematic strategies based on financial theory.

The theoretical foundation is formed by two major schools of thought, which center around the question whether firm value can be enhanced by financial BSM. On the one hand, *Modigliani/Miller* (1958) argue that the firm value is independent of the liability side of the balance sheet – under the assumption of perfect capital markets. On the other hand, *Froot/Scharfstein/Stein* (1993, 1994) relax the perfect capital markets assumption and provide evidence for a positive value effect of BSM measures, such as the stabilization of cash flows by means of hedging. *Kürsten* (2006) highlights that hedging may increase firm value by reducing expected costs of financial distress.

For commercial banks, such as Swiss cantonal and regional banks, the major source of cash flows is net interest income (*Swiss National Bank* 2007). Commercial banks generate net interest income *(NII)* mainly through (a) the margins on products in excess of market interest rates and (b) the risks assumed in transforming liquid customer deposits into long-term loans and mortgages. Profit source (a) is limited by competition in the marketplace, while profit source (b) is limited by regulatory requirements as well as a bank's ability and willingness to assume interest rate risk.

Despite the importance of interest rate risk, little research to date has methodically explored strategies in financial BSM. Thus, the purpose of our paper is to provide a systematic framework for the analysis of strategies in BSM. We define a BSM strategy as a set of rules to attain a certain target risk/ return profile of the balance sheet. Specifically, we introduce a categorization of BSM strategies based on two fundamental questions in financial theory: (1) Can BSM measures create value? (2) Does a bank possess superior capabilities to anticipate interest rate movements? By linking BSM strategies to these fundamental questions, we are able to provide normative conclusions based on the risk philosophy of a bank's management. Furthermore, we provide empirical evidence regarding the performance of different BSM strategies.

The paper proceeds as follows: Section 2 reviews previous research on key concepts relating to BSM. Section 3 introduces a categorization of financial BSM strategies. Section 4 discusses the empirical methodology, including performance measures, the data sample, and the simulation set-up. Section 5 presents the empirical results on the performance of different BSM strategies based on the real monthly assets and liabilities of a Swiss cantonal bank. Section 6 concludes the analysis.

2 Literature Review

A number of authors have made contributions in the field of commercial BSM, by modeling relationships between customer demand and financial variables in microeconomic settings. In general, these models provide an economic rationale for the basic function of commercial banks to transform short-term, floating-rate customer deposits into long-term, fixed-rate loans and mortgages. This short-term funding of long-term assets is referred to as «positive term transformation»; the commercial bank engaging in positive term transformation is said to have an «asset-sensitive» balance sheet or a «positive balance sheet gap.»[1]

Von Furstenberg (1973) presents an economic equilibrium model to justify the positive spread between fixed- and floating-rate mortgages, which is based on the preferences of borrowers and lenders.[2] *Von Furstenberg*'s model points to the profit opportunities for commercial banks offered by positive term transformation. *Morgan/Smith* (1987) argue that the optimal commercial BSM strategy is dependent on the expected correlation of future deposit rates and loan demand. If deposit rates and loan demand are positively correlated, the optimal strategy involves a positive balance sheet gap. *Santomero* (1983) determines an optimal commercial BSM strategy by modeling the joint distribution of interest rates and the return on the project underlying a loan. Evidence is provided that projects, whose returns are highly correlated with interest rates, should be financed by floating-rate loans. *Kürsten* (1992, 1998) highlights how commercial BSM is affected by the (simultaneous or anticipated) possibility to engage in interest rate derivatives (financial BSM). Thus, *Kürsten* demonstrates the interrelationship between commercial and financial BSM, which could produce a positive «production effect» for commercial banks.

Focusing on financial BSM, *Froot/Scharfstein/Stein* (1993) analyze optimal hedging decisions in a framework of capital market imperfections. They point out that BSM in the form of hedging increases firm value to the extent that it ensures sufficient internal funding of investment opportunities. Under the presumption that internal funds are less costly than external sources of finance, financial BSM enhances firm value.

An individual rationale for corporate hedging is described in *Stulz* (1984), who argues that hedging is a result of management's risk aversions. Managers, who hold a relatively large, undiversified portion of their wealth in the firm's stock, profit from hedging as it reduces the variance of the firm value. *De Marzo/Duffie* (1992) relate to this individualistic argument by highlighting the importance of the labor market perception on managers' decision making. Some managers may use financial BSM measures to influence this perception. This argument, however, implies that financial BSM measures have a positive effect on firm value.

A corporate rationale for hedging is described by *Smith/Stulz* (1985), who argue that hedging can reduce a firm's tax burden. In the case of progressive tax regimes, more volatile earnings lead to a higher average tax rate. Therefore it is rational from a corporate income tax perspective to reduce earnings volatility by financial BSM measures (*Smithson/Smith/Wilford* 1995). According to *Miller* (1977) the presence of bankruptcy costs adds another explanation of why hedging may be favorable to firm value. A further argument is the direct positive impact of hedging on a bank's strategic flexibility and the resulting ability to participate in particular market segments (*Carey/Stulz* 2005).

Kürsten (2006) suggests that the motives of hedging can be categorized into regulation- and market-induced hedging motives. While regulation-induced hedging is a reaction to regulatory requirements and typically plays to the interests of a wider group of stakeholders, market-induced hedging is based on managerial decisions, which should be in accordance with the maximization of shareholder value. By reviewing the existing literature on hedging, *Kürsten* points out that most arguments in favor of hedging are not necessarily in line with the maximization of shareholder value.[3] Following this reasoning, we analyze the empirical risk and return of different BSM strategies from a shareholder value perspective.

3 Types of BSM Strategies

Financial institutions have to manage interest rate risk as a major source of risk that affects their balance sheets. In particular commercial banks, whose balance sheets are dominated by interest rate-sensitive positions such as loans and mortgages, focus on interest rates as the major source of risk. Therefore, the following categorization of strategies focuses on interest rate risk and return considerations as most significant measures for steering the balance sheet.

To provide a framework for specifying and comparing BSM strategies, we propose a categorization along two fundamental questions in financial theory. We are not aware of any systematic treatment of BSM strategies to date.

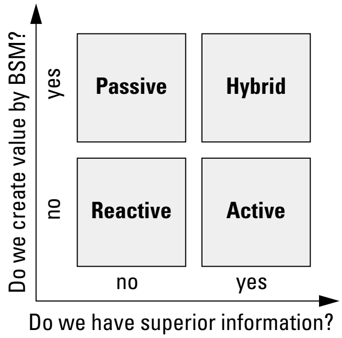
The first question is whether the value of a bank can be enhanced by financial BSM. As mentioned above, while *Modigliani/Miller* (MM, 1958) argue that the value of a bank is independent of the liability side of the balance sheet, *Froot/Scharfstein/Stein* (FSS, 1993, 1994) provide evidence for a positive value effect of financial BSM.

The second question is whether a bank possesses the capabilities to forecast future interest rates better than the capital market in general. We denote the case of no superior information by MI (market information), while the availability of superior information to the bank is denoted by SI (superior information).

MI: Today many financial institutions take stakes in capital and derivative markets and one can hardly believe that a particular bank, such as a mid-sized commercial bank, should possess a superior ability to forecast interest rate movements. In the case of average market information, economic theory therefore suggests to follow a passive buy-and-hold strategy with respect to interest rate risk in order to maximize the expected return within a bank's risk budget.

SI: On the other hand, some observations support the hypothesis that banks may have, at times, superior knowledge of future interest rate movements. Since commercial banks have close relationships to credit demanding firms, they receive early indicators of the business climate, while central banks and non-bank financial institutions tend to rely on aggregate statistics. This early private information could allow commercial banks to infer upcoming actions of central banks and other financial institutions. If this reasoning were true, commercial banks should be able to reach superior returns by actively shifting their risk exposure over time. However, the hypothesis SI is not yet empirically supported. Therefore we must conclude that banks are clearly prepared, by their general expertise, to take and to control interest rate risk, while it remains unclear whether they can forecast interest rates better than the aggregate capital market.

Management's answer to these two fundamental questions determines the type of BSM strategy to be pursued by the bank. Our approach distinguishes four types of BSM strategies based on the answers to these questions.



▲ Fig. 1 Categorization of BSM strategies

◄ Figure 1 illustrates this classification along the distinction between MM and FSS, and between MI and SI.

3.1 Reactive Strategy

If a bank believes that it can neither create value by financial BSM (MM) nor that it possesses the ability to outguess the market (MI), it should not engage in financial markets to actively structure its balance sheet, i.e. a *reactive* strategy seems appropriate. This means that by meeting customer, demand the bank takes interest rate risk only as a result of its commercial activities. Customer demand therefore effectively determines the bank's risk exposure. The bank hedges interest rate risk only when regulatory limits are violated.

3.2 Passive Strategy

A *passive* strategy is appropriate, if a bank concludes that value can be created by financial BSM (FSS), but superior information regarding future interest rate movements is not available (MI). With a passive BSM strategy, a bank pursues a constant risk exposure over the long term and thus abstains from tactical portfolio management. The bank regularly rebalances the portfolio, when new lending and/or borrowing activities cause the actual risk exposure to diverge from its target. In practice, the board sets a risk budget, which is then specified by management into a BSM strategy that maximizes the expected return within the given budget.

The most straight forward passive BSM strategy is to perfectly hedge the repricing profiles of assets and liabilities. However, since the equity portion of the liability side has no repricing date, such a perfect BSM strategy is impossible. Conceptually, we regard it useful to think of the aggregated («netted») key rate profile of assets and liabilities as the interest rate risk exposure of equity. Thus, the bank is only confronted with the decision to invest the equity across maturities (*Toevs/Haney* 1986). An excess of liabilities over assets in specific key rate time bands can be thought of as «leverage», which allows investing more capital across the other key rate time bands.

Since the analysis focuses on interest rate-sensitive balance sheets, we consider duration and convexity as the major concepts to control and quantify the risk/return profile. Hence three generic duration approaches can be defined:[4]

1. In a *low-duration approach,* the bank invests the equity in short-term commercial papers, which keeps liquidity at a high level. This leads to rather low and volatile earnings, due to the normally upward-sloping shape of the yield curve and the relatively high volatility of short-term money market rates.
2. In a *medium-duration approach,* the bank invests its equity in long-term bonds. This approach leads to higher and more stable earnings due to the term premium in the yield curve.
3. In a *high-duration approach,* the bank enters a «leveraged balance sheet», i.e. it borrows short term and invests the additional capital along with the equity in long-term bonds. This «carry strategy» pays the spread between the short-term borrowing cost and the long-term bond yield, but leaves the bank exposed to substantial volatility in earnings *and* the market value of equity. As a result of the higher risk, this approach yields the highest expected return.

Besides determining the target duration, the decision maker has to set the desired convexity of the bond portfolio's present value curve. In fixed-income investing, convexity is interpreted as an insurance component, since it makes the investor better off with both positive and negative interest rate movements. There are three generic convexity approaches:

1. A *benchmark approach* involves distributing the equity evenly across the investment horizon. The maturing amount has to be constantly reinvested in the longest maturity. In general, a benchmark approach reduces reinvestment risk and thereby smoothes *NII* over time through its roll-over investments.
2. A *barbell approach* involves investing only in short and long term maturities, leaving out the intermediate term – hence the term «barbell.» It could be implemented by a combination of short-term commercial papers and long-term constant-maturity bonds. This approach is characterized by an excess convexity over the benchmark strategy. Consequently, the market requires a premium for the benefits of convexity, which leads to a lower expected return in comparison to the benchmark approach (*Spremann/Gantenbein* 2002).
3. A *bullet approach* involves investing all the equity in bonds with intermediate maturities. It features a lower convexity and thus a higher expected return compared to the benchmark approach.

3.3 Active Strategy

If a bank believes that it cannot create value by financial BSM (MM), but it has superior information on future interest rate movements (SI), the selection of an active BSM strategy is supported. A bank following an active strategy bases its target risk exposure on its interest rate forecast. If the bank forecasts forward rates to be higher (lower) than future spot rates, it will adopt a positive (negative) balance sheet gap (*Morgan/Smith* 1987). Thus, the bank has to regularly shift between a positive and negative balance sheet gap in order to exploit windows of opportunity that certain yield curves offer.

A basic active BSM strategy could be founded on the segmentation theory of the term structure of interest rates put forward by *Culbertson* (1957) and *Modigliani/Sutch* (1966). This theory says that short-term and long-term interest rates move independently of each other, since they are set in distinct markets that are not easily substituted for each other. Following this line of reasoning, a bank that wishes to maximize its *NII* will adopt a positive (negative) balance sheet gap, whenever long-term rates are higher (lower) than short-term rates.

The exact specification of an active BSM strategy will depend on the risk appetite and risk capacity of the bank, as well as its confidence in its own interest rate forecast. The more uncertain future interest rates are, the smaller the repricing imbalances should be. If the bank is not capable of systemically beating the market, it should consider a passive or reactive approach to BSM.

Every active strategy is demanding, since it requires complex trading procedures. Optimal trading procedures to exploit interest rate forecasts may be analytically derived by means of Dynamic Optimization (*Ziemba/Mulvey* 1998, *Kouwenberg/Zenios* 2001). Some active approaches to BSM also integrate interest rate risk and credit risk (*Jarrow/Turnbull* 2000).

3.4 Hybrid Strategy

If a bank can both create value by financial BSM (FSS) and forecast interest rates better than the market (SI), the management of a bank faces a trade-off. On the one hand, stabilizing the bank's earnings and market value limits the opportunities to generate abnormal returns by using the superior information. On the other hand, exploiting certain opportunities that yield curves offer requires the bank to selectively assume interest rate risk, which will reduce the positive value effects of hedging. Concluding, hybrid strategies can be expected to combine elements of both passive and active strategies.

4 Empirical Methodology

This section describes the simulation model, which will be used to analyze the performance of several BSM strategies. First, we discuss performance measures in BSM; then, we specify the used data sample; finally, we present the set-up of the simulation model.

4.1 Performance Measures

Performance measures compare the return of a particular strategy to a benchmark strategy that shares similar risk characteristics. The intuition behind most performance measures is that there exists a linear trade-off between risk and return. Because performance measurement in BSM still lacks a standard approach, this part discusses the two major schools of thought on risk and return in BSM, the accounting-based earnings and the finance-based economic capital perspective.

The earnings perspective considers how changes in interest rates affect a bank's accrual and reported earnings over a defined planning horizon. In practice, the assessment of bank earnings usually involves modeling the *NII* under several market scenarios over the next two or three years. Often banks create risk limits around the volatility of the simulated *NII*. The economic capital perspective measures the gains and losses from interest rate movements in economic terms. The economic capital of a bank is the «present value of the bank's expected net cash flows, defined as the expected cash flows on assets minus the expected cash flows on liabilities plus the expected net cash flows on OBS [off-balance sheet] positions» (*BCBS* 2004).[5]

The risk characteristics of a fixed-rate bond and a floating-rate note (FRN) illustrate the fundamental difference between the two perspectives. The cash flows of a fixed-rate bond are irrevocably set. Therefore, *NII* is immunized against changes in interest rates. However, the market value of the fixed-rate bond is sensitive to changes in the yield curve, because the spot rates are used to discount the corresponding cash flows. Conversely, the market value of a FRN remains stable, but its cash flows change whenever interest rates move. A FRN is characterized by the fact that its coupon rate is reset at regular intervals based on a short-term index rate. If interest rates rise, the increase in coupon exactly offsets the increase in the discount rate, leaving the present value of the FRN unchanged.

Applying this illustration to BSM it becomes clear, that a bank cannot simultaneously immunize earnings and economic capital. It has to decide on an interest rate positioning that implies volatility in at least one perspective. Thus, the task of BSM is to find an acceptable and mutually attainable risk level for each perspective (*Toevs/Haney* 1986, *Uyemura/Van Deventer* 1993).

Based on conversations with the management of a Swiss cantonal bank, the primary objective of BSM strategies is to cost-efficiently stabilize earnings, i.e. to attain a high and stable *NII.* As discussed above, the reasons for stabilizing earnings are, among others, reduced costs of financial distress, reduced taxes, and enhanced strategic flexibility. Besides high and stable earnings, management also aims at keeping the economic capital exposure and liquidity levels within certain boundaries. To account for the economic capital perspective and liquidity, management may exclude BSM strategies, which exceed a certain duration limit. Due to the dominance of the earnings perspective, we evaluate BSM strategies in terms of the total amount and the stability of monthly *NII* in the simulation model.

The goal of a bank pursuing a reactive or active BSM strategy is to simply maximize its *NII,* since it does not believe that financial BSM will create values. The bank will have the following target function:

$$(1)\ \max.\ NII = \sum_T (r_T + \overline{m}_{L,T}) \times L_T - \sum_T (r_T + \overline{m}_{D,T}) \times D_T + \sum_T (f_T - r_T) \times S_T$$

where r_T and f_T are market spot and forward rate for duration *T,* $\overline{m}_{L,T}$ and $\overline{m}_{D,T}$ are the weighted average margin above the (term-congruent) market interest rate for loans and deposits, and L_T, D_T, and S_T are the notional values of loans, deposits, and swaps with duration *T,* respectively.

However, the above target function *(Equation 1)* does not take account of the risk exposure a bank faces. Several performance measures have been introduced to incorporate the risk elements into the target function of a bank. An established concept is the Return on Risk Adjusted Capital *(RORAC),* which scales the profit of a bank *(NII)* by the capital required for a given risk exposure (risk-adjusted capital, *RAC*). In line with the earnings perspective of management, the *RAC* can be modeled as a function of (a) the volatility of *NII* for interest rate risk and (b) the average total assets for credit, liquidity, and operational risk. Assuming a linear relationship yields the following risk-adjusted target function:

$$(2)\ \max.\ RORAC = \frac{NII}{RAC} = \frac{NII}{F \times \sigma_{NII} + R \times TA}$$

where the constant *F* reflects the risk aversion of the bank with respect to interest rate risk and the constant *R* reflects the economic exposure regarding the other risk categories. For our analysis, we model the *RAC* as ten times the volatility of *NII* plus eight percent times the total assets of the Swiss cantonal bank ($F = 10$, $R = 8\,\%$).[6]

There are several possible modifications to this risk-adjusted target function *(Equation 2).* For instance, a bank could focus on the downside risk to *NII,* with a measure such as Earnings-at-Risk, or it could include the economic capital perspective into the definition of risk.

4.2 Data Sample

The simulation model requires historical data with respect to (1) the risk exposure of the bank's balance sheet, (2) the earnings position of the bank, and (3) market interest rates. The simulation horizon spans the 75 monthly data points from February 2000 to April 2006.

Concerning the risk exposure of the Swiss cantonal bank, the simulation model is based on the «repricing gap profile» of the balance sheet, which is a widely used tool for measuring and controlling the interest rate risk exposure of a bank. Initially, the repricing date of each interest rate-sensitive position is determined, which is typically the maturity for fixed-rate and the next repricing date for floating-rate positions.[7] Then, all positions with similar repricing dates are grouped into so-called «timebands.» Finally, the assets and liabilities within a timeband are netted to attain a single repricing gap for that timeband. The pattern of repricing gaps for all timebands is referred to as «repricing gap profile.»

Two specifications of the repricing gap profile are necessary. First, the timeband structure describes the time intervals, in which the assets and liabilities with corresponding repricing dates are grouped. We use yearly timebands up to ten years and one additional timeband for all positions with repricing dates exceeding ten years. Second, the «center of gravity» of a specific timeband describes the assumed repricing date for that repricing gap. In line with common banking practice, we set the repricing date to the middle of each timeband; for the additional timeband, a repricing date of 12.5 years is assumed.

Concerning the earnings position, we use the monthly *NII* of a Swiss cantonal bank. Please note that the *NII* includes both (a) the margins on products in excess of market interest rates and (b) the risk premium for transforming short-term, floating-rate customer deposits into long-term, fixed-rate loans and mortgages. Thus, the choice of *NII* as performance variable includes the impact of customer behavior on the volume and the structure of the bank's balance sheet. These «structural effects» matter, because the margins on products in excess of market interest rates systematically depend on movements in the term structure of interest rates (*Day* 2005).

Concerning market data, the relevant CHF interest rates are retrieved from the Thomson Datastream database. We use interbanking rates for maturities up to twelve months and swap rates for longer maturities. Interest rates are linearly interpolated to calculate the rates corresponding to the center of gravity of each timeband. (▶ Table 1 provides some descriptive statistics of the data sample.)

Simulation horizon: February 2000 to April 2006							
Simulation period: Monthly							
Number of periods: 75							
Panel A: Gap Profile Bank[1, 3]	< 1Y	1–2Y	2–3Y	3–5Y	5–7Y	> 7Y	
Average	–132 %	24 %	123 %	159 %	–50 %	–25 %	
Panel B: Profitability Bank[1]	Average	Sigma[4]	Min	Max			
Return on Equity[5]	25.0 %	3.7 %	17.5 %	31.8 %			
Panel B: Market Data[2]	6M	12M	2Y	3Y	5Y	7Y	10Y
Average Interest Rate	1.52 %	1.68 %	2.03 %	2.29 %	2.65 %	2.92 %	3.21 %
Sigma[4]	1.17 %	1.15 %	1.06 %	0.97 %	0.82 %	0.74 %	0.69 %
Min Interest Rate	0.30 %	0.40 %	0.76 %	1.11 %	1.66 %	1.93 %	2.20 %
Max Interest Rate	3.76 %	3.97 %	4.19 %	4.30 %	4.41 %	4.53 %	4.70 %

Note: (1) The gap profile and the profitability figures are based on the hybrid BSM strategy actually adopted by the Swiss cantonal bank, i.e. including the portfolio of interest rate derivatives. (2) «Market Data» refers to CHF interest rates from Thomson Datastream. (3) The Gap Profile figures are stated in % of the book value of equity. (4) Sigma is the standard deviation of the respective time series. (5) Return on equity is calculated as the annualized monthly NII divided by the average book value of equity for the respective month.

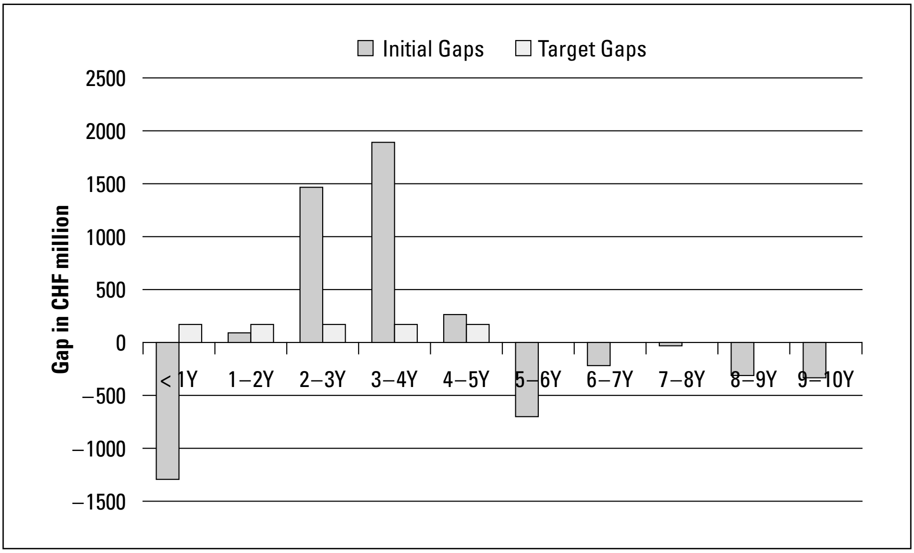
▲ Tab. 1 Descriptive statistics

4.3 Simulation Setup

Simulations allow quantifying the performance of different BSM strategies under several scenarios. A historical simulation uses past data as a guide to what might happen in the future. It addresses the following question: What would have been the risk and return, if the bank had pursued the simulated BSM strategy? Historical simulations make the pivotal assumption that the parameters derived from past data are representative for the stochastic behavior in the future, i.e. there is no «regime switch» in the dynamics of interest rates and client behavior. The advantage of this approach is that historical data includes the joint probability distribution of all market variables (*Hull* 2006).

The simulation proceeds as follows: The repricing gap profile and the *NII* of the hybrid strategy actually adopted by the Swiss cantonal bank, which includes the derivative portfolio actually held, are the starting points. The simulation model then adds the interest rate derivatives necessary to attain the target risk exposure of the simulated BSM strategy. The result of the simulation is the repricing gap profile and the *NII* of the simulated strategy for each month over the simulation horizon.

Next, we discuss in more detail how the necessary interest rate derivatives are determined and how the income of this derivative portfolio is calculated. Our simulation model allows for a monthly rebalancing of the derivative portfolio. For illustration, ▶ Figure 2 shows the actual repricing gap profile for a particular month (dark gray) together with the target gap profile of a sample BSM strategy (light gray). In order to attain the target gap profile, the bank has to enter several interest rate derivatives.



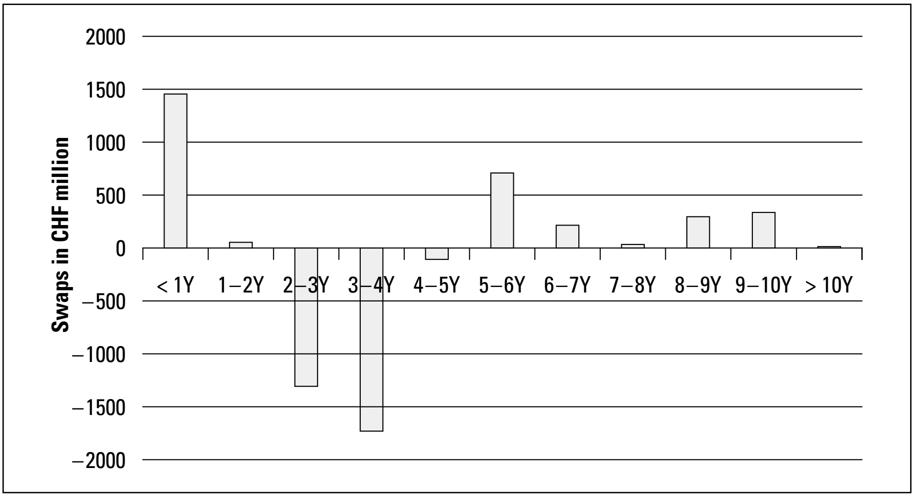
▲ Fig. 2 Comparing the actual and the target gap profile

The simulation model uses interest rate swaps of different maturities as the building blocks of the derivative portfolio. The reason for this choice is twofold. First, swaps allow attaining any target exposure in the repricing gap profile framework. Second, swaps are the most common hedging instruments in practice. A swap is an agreement to exchange interest payments for a certain period of time, while the underlying interest paying assets remain with the respective swap parties. In a payer swap interest payments are made at a fixed rate (the «fixed leg»), while the counterparty delivers interest payments at a floating rate (the «floating leg»). The reverse applies to a receiver swap.

To attain the target repricing gap profile, the necessary swap positions are matched to the differences between the actual and the target gaps for each timeband. ▶ Figure 3 shows the required swap positions for the illustration above. The figure provides the direction of the swaps, i.e. payer or receiver swap, the nominal value, and the maturity dates. If the column in ▶ Figure 3 is positive (negative), a receiver (payer) swap must be entered.

The second step involves the calculation of the income of the swap portfolio. The calculation requires the market swap rate for the respective maturity, a floating rate, and a Day Count Convention (DCC) for each leg of the swap.[8] For ease of exposition, we first analyze a single swap position and then extend the calculation to the entire swap portfolio.

The interest payment of the «fixed leg» is calculated by multiplying the nominal amount of the swap with the respective market swap rate. To obtain the monthly income, the annual income is multiplied by a DCC factor, which specifies the number of days each month and year is assumed to have for calculating the swap payments. As swaps are over-the-counter products, the



▲ Fig. 3 Required swaps to attain the target gap profile

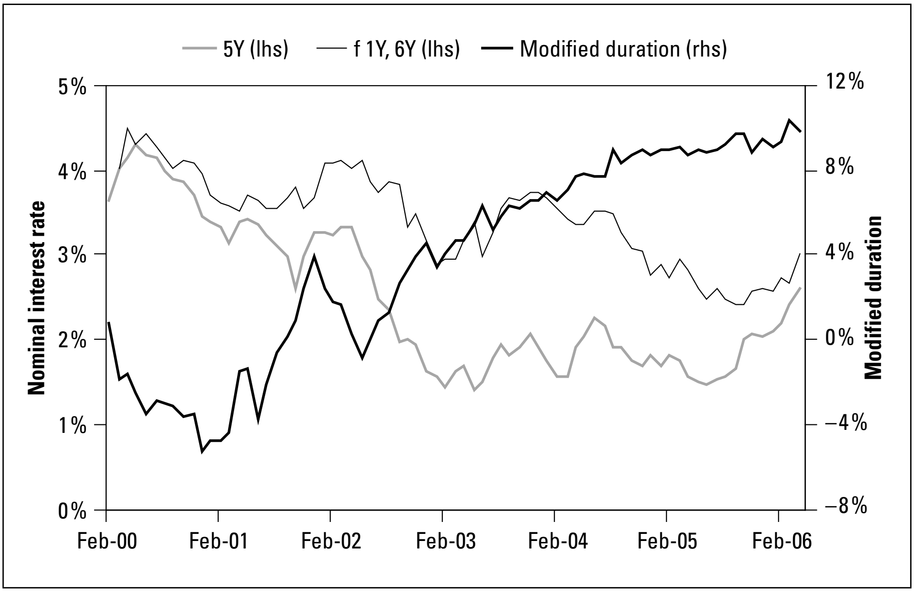
payment schedule, reference rates and DCC can be customized to the specific needs of the parties. For the purpose of hedging, the DCC of the fixed leg is chosen to match that of the position to be hedged. We use the standard actual/365 DCC for calculating the income of the fixed leg. Similarly, the interest payment of the swap's «floating leg» is calculated by multiplying the nominal amount of the swap by a money market rate, which is usually reset every six months. To obtain the monthly income, the annualized income is multiplied by a DCC factor. We use the standard actual/360 DCC for the floating leg.

For each month, the net income of a payer (receiver) swap is the income of the floating (fixed) leg minus the cost of the fixed (floating) leg. The total income of the swap portfolio is the sum of the net income of all active swaps.

5 Empirical Results

This section discusses the empirical risk/return characteristics of the hybrid strategy actually adopted by the Swiss cantonal bank and compares it to the performance of simulated reactive, passive, and active BSM strategies. (▶ Table 2 summarizes the performance of four selected BSM strategies.)

When interpreting the results of the historical simulation, keep the intricate relationship between risk and return in mind: If a bank assumes higher volatility of earnings or economic capital, it should also expect higher returns. If the bank hedges this risk, it foregoes some of the risk premium. Hence, from a shareholder value perspective, the objective of BSM strategies is not to maximize expected returns, but to optimize the balance sheet's risk/return structure (*Giarla* 1991).



▲ Fig. 4 Illustration of the hybrid strategy adopted by the Swiss cantonal bank

Hybrid strategy: As mentioned before, the hybrid BSM strategy will combine elements of both active and passive strategies. With respect to the active element, the bank will target a positive (negative) balance sheet gap, whenever the bank expects future spot rates to be below (above) implied forward rates. Blending the passive element, the bank will pursue this active strategy considering its risk appetite and risk capacity.

◀ Figure 4 illustrates how the Swiss cantonal bank adhered to this hybrid strategy. The grey line is the continuously compounded 5-year spot rate, the black line is the forward rate for a 5-year bond in 12 months, and the solid black line is the effective modified duration of the Swiss cantonal bank. With perfect foresight, the bank would pursue an asset-sensitive balance sheet, if the future spot rates (grey line) were below implied forward rates (black line), and vice versa. ◀ Figure 4 shows that the Swiss cantonal bank actually adopted a liability-sensitive balance sheet, i.e. negative modified duration, during the period from March 2000 to August 2001, when realized spot rates closely matched implied forward rates. The bank shifted to an increasingly asset-sensitive position after June 2002, when forward rates significantly overestimated realized spot rates. Concluding, the bank clearly benefited from adopting a positive balance sheet gap after June 2002. However, only a comparison with the reactive strategy can show, whether the shift of the risk profile was the result of commercial (changed customer behavior) or financial (interest rate swaps) BSM measures.

Reactive strategy: Following a reactive BSM strategy, the bank would not enter swaps to structure the balance sheet. Essentially, the reactive strategy is

Measures	Hybrid[1]	Reactive[2]	Passive[3]	Active[4]
Net Interest Income (CHF million)[5]	22.5	22.0	22.6	25.4
Volatility (CHF million)[6]	2.09	2.14	2.37	3.51
Abs. Duration (average)[7]	5.2%	nk	5.8%	13.7%
Abs. Duration (max)[7]	10.3%	nk	6.0%	14.3%
RORAC[8]	28.1%	27.3%	27.9%	30.1%

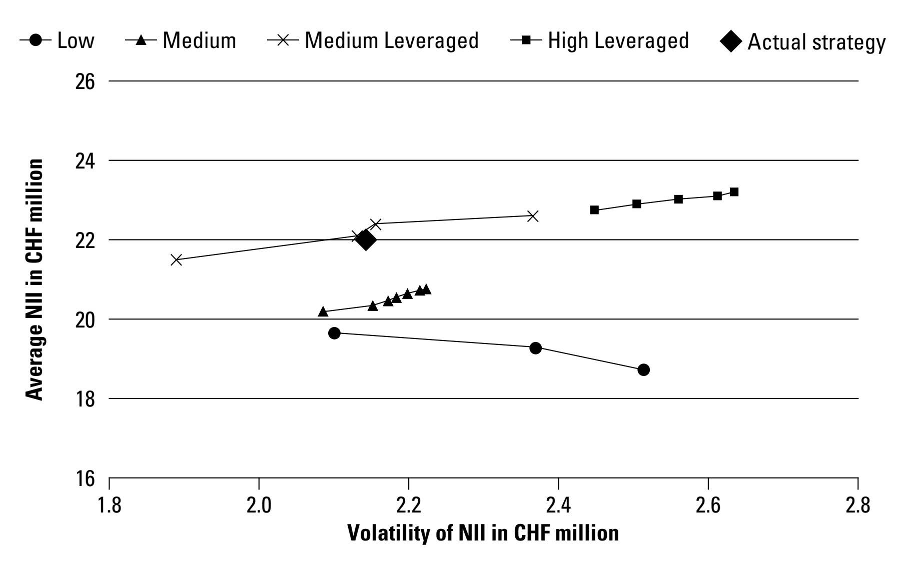
Note: (1) The hybrid strategy is the strategy actually adopted by the Swiss cantonal bank, i.e. including the swap portfolio. (2) The reactive strategy is the strategy actually adopted by the Swiss cantonal bank minus the swap portfolio. (3) The passive strategy is a 100 percent leveraged 6-year benchmark strategy. (4) The active strategy is a 200 percent leveraged 12.5-year benchmark strategy, since the long-term rates are above short-term rates over the entire simulation horizon. (5) The net interest income is the average monthly net interest income over the simulation horizon. (6) The volatility is defined as the standard deviation of the monthly net interest income. (7) The duration figure is computed as the average absolute modified duration. (8) The RORAC figures are calculated based on Equation 2 with F = 10 and R = 8%.

▲ Tab. 2 Performance of selected BSM strategies

the hybrid strategy actually adopted by the Swiss cantonal bank minus the swap portfolio. ◂ Table 2 shows that the active element of the hybrid BSM strategy of the bank actually managed to both increase the average monthly *NII* (from 22.0 to 22.5 CHF million, i.e. +2.3%) and decrease the volatility of the monthly *NII* (from 2.14 to 2.09 CHF million) over the simulation horizon.[9] Thus, the hybrid strategy exhibits a better *RORAC* than the reactive strategy.

Passive strategy: A passive BSM strategy pursues a constant risk exposure over the long term. The prevalent passive strategy is the benchmark strategy, which involves investing a constant proportion of the portfolio equity across a specified investment horizon. For illustration, ◂ Figure 3 in section 4 shows the target repricing profile of a 5-year benchmark strategy. The target gap profile can be best described by a vector that specifies the percentage of the book value of equity invested in each timeband. For instance, the 5-year benchmark strategy in ◂ Figure 3 has 20% weights in each of the first five timebands and 0% weights in the remaining timebands.

Different benchmark strategies can be effectively characterized by the economic capital measure «duration». The duration of a benchmark strategy generally depends on (a) the horizon over which the equity is invested as well as (b) the extent of «leverage». In this context, «leverage» can be described as negative repricing gaps for the short-term timebands; i.e. a bank borrows short-term funds and invests the additional capital along with the equity in intermediate- or long-term maturities. The longer the investment horizon and the higher the leverage, the higher the duration will be. ▸ Figure 5 compares the total *NII* and the volatility of the monthly *NII* for low-, medium-, and high-duration strategies. Each marker in ▸ Figure 5 represents a combination of (a) a specific investment horizon and (b) an unleveraged or leveraged approach. For instance, the three dots stand for unleveraged benchmark strategies with investment horizons of one, two, and three years. (Please refer to the *Appendix* for additional information on the performance of the displayed benchmark strategies.)



▲ Fig. 5 Performance of different benchmark strategies

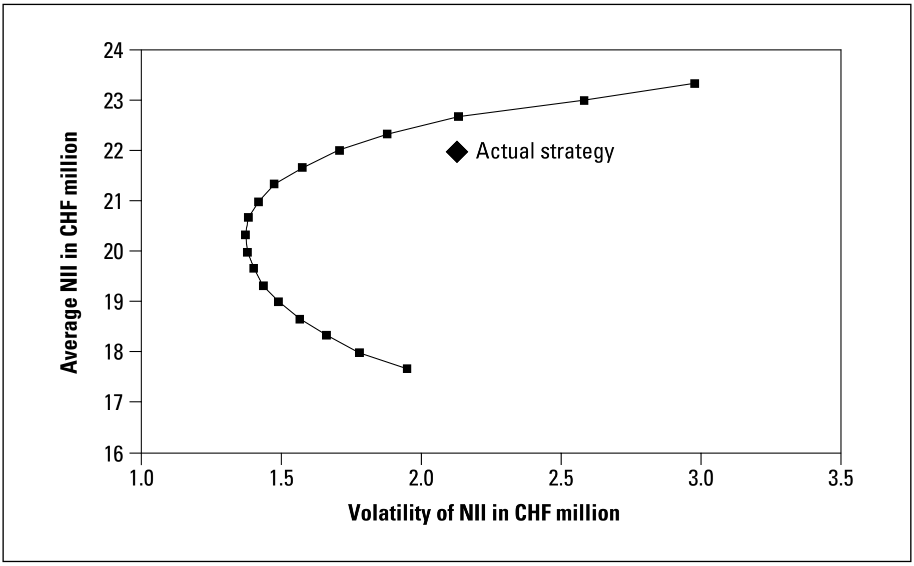
Low-duration benchmark strategies feature effective modified durations of less than two percent. This involves investing the portfolio equity in maturities up to three and a half years. The fact that the line with dots in ◂ Figure 5 is sloping downward implies that benchmark strategies with a very short investment horizon are not mean-variance efficient. For medium-duration benchmark strategies, the effective modified duration lies between two and six percent. There are two ways to attain such an interest rate risk exposure. First, the bank could invest the portfolio equity in long-term bonds with maturities up to twelve and a half years, which is represented by the line with triangles. Second, turning to leveraged approaches, the line with crosses in ◂ Figure 5 illustrates the strategy of borrowing 100 percent of the portfolio equity on a 6-month roll-over basis and investing the additional capital in bonds with maturities of up to five and a half years. This leveraged strategy clearly dominates its counterparts with the same duration over the simulation horizon. High-duration benchmark strategies feature effective modified durations of more than six percent, which involves investing the 100 percent leveraged equity in long-term bonds.

With respect to the relative performance of benchmark strategies, it can be observed that a higher characteristic duration generally leads to a higher average *NII.* In other words, positive term transformation provided a positive return over the simulation horizon, because implied forward rates exceeded realized spot rates on average. Compared to the hybrid strategy actually adopted, six out of the 21 analyzed benchmark strategies provide a higher average *NII;* however, only the 3-year leveraged strategy offers a higher *RORAC.*

From a conceptual perspective, it is also useful to think of the performance of BSM strategies in terms of how their risk and return characteristics deviate from a perfectly hedged, low-duration strategy, such as the 1-year unleveraged benchmark strategy. The additional return generated by positive term transformation, and thus the assumption of interest rate risk, can be viewed as a «term structure carry» strategy, as pursued by many fixed-income hedge funds.

In order to derive optimized risk/return target gap profiles for the balance sheet, we use the classical Markowitz-routine, which is to minimize the standard deviation for a given *NII* target return. We impose three restrictions on the optimization. First, the absolute modified duration should not exceed seven percent. Second, each absolute modified key rate duration has to stay within five percent. Third, the maximum repricing gap for each timeband must not exceed 100 percent of the book value of equity. ▶ Figure 6 illustrates the resulting efficient frontier, which is the upper part of the hyperbola. In practice, the choice of a target gap profile can be restricted by a minimum *NII* level, which is needed to keep liquidity at the desired and necessary level. For comparison, the risk/return characteristic of the hybrid strategy, which was actually adopted by the Swiss cantonal bank, is illustrated by the diamond in ▶ Figure 6.

We can conclude from the optimization that the hybrid strategy actually adopted was not mean-variance efficient. In retrospect, the bank could have gained a higher *NII* for the chosen level of risk by structuring its balance sheet differently. However, it has to be pointed out that the performed optimization is based on past, realized interest rates and therefore does not address the ques-



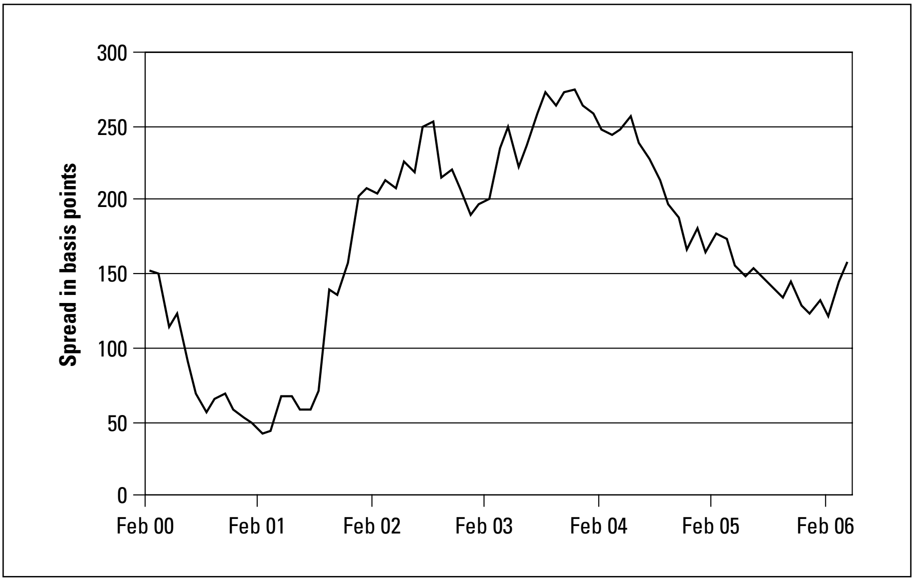
▲ Fig. 6 Efficient frontier of passive BSM strategies tion of future parameter uncertainty. Best practices in building more efficient *prospective* strategies include Monte Carlo Simulations and Time Series Analyses of the variables in question.

Active strategy: As discussed in section 3, a basic active BSM strategy, based on the segmentation theory of the term structure of interest rates, would adopt a positive (negative) balance sheet gap, whenever long-term rates are higher (lower) than short-term rates.

▶ Figure 7 shows that the spread between long-term rates and short-term rates has been positive over the entire simulation, i.e. long-term rates have been higher than short-term rates. Thus, the active strategy would have consistently suggested a positive balance sheet gap.

Since a bank following an active strategy does not believe in the positive value effect of hedging, it is expected to aggressively pursue positive term transformation. In the regime of a rising yield curve, we assume a 200 percent leveraged 12.5-year benchmark strategy.

Compared to the hybrid strategy of the Swiss cantonal bank, the basic active strategy would have generated a significantly higher *NII* (25.4 vs. 22.5 CHF million, i.e. +12.9%, compare ◀ Table 2). Since the bank following an active strategy is only concerned with maximizing profit *(Equation 1),* this result would have served the management of the bank very well. However, an aggressive active strategy achieved the higher *NII* only at the expense of a significantly higher volatility of *NII* (3.51 vs. 2.09 CHF million). Even more considerable would have been the increase in the average absolute modified duration from 5.2% for the hybrid strategy to 13.7% for the modeled active



▲ Fig. 7 Spread between the 10-year swap rate and the 6-month money market rate strategy. However, since the risk-adjusted target function *(Equation 2)* does not reflect the economic capital perspective, the active strategy exhibits the highest *RORAC* of all simulated strategies (30.1 % compared to 28.1 % for the hybrid strategy, compare ◂ Table 2).

6 Conclusion

In our paper, we propose to categorize BSM strategies along two fundamental questions regarding the value-added of BSM and the forecasting capabilities of a bank. We argue that management's answers to these questions determine the type of BSM strategy to be pursued by a financial institution, in our case a bank. Four strategies are distinguished and discussed in a comparative performance analysis. Our methodology is a simulation based on historical interest rates and real assets and liabilities of a Swiss cantonal bank. The results strongly support a «leveraged passive» BSM strategy, i.e. a balance sheet with a short-term liability overhang. Besides, an active BSM strategy is a viable option, if a bank possesses superior capabilities to forecast interest rates.

In addition, our paper sheds light on the relationship between risk and return of different BSM strategies. Overall, we observe that there is a clear trade-off between risk and return, in both the earnings and the economic capital perspective. This observation indicates that the market compensates both types of interest rate risks. At the same time, we demonstrate that some BSM strategies clearly dominate others, thus, a careful definition and selection of BSM strategies is essential.

There are several possible extensions to our study. Further research could adopt separate BSM strategies for product lines, especially with regard to embedded options embedded in variable-rate mortgages and customer deposits. The intuition of such an approach in a BSM framework is to explicitly address the option component of products with non-linear interest rate derivatives, such as swaptions, caplets, or floorlets. From a practical perspective, the feasibility of specific BSM strategies has to be examined in the light of transaction costs and hedge accounting (see for instance *KPMG* 2004 and *IASB* 2003). In addition, more extensive research is needed to assess the validity of our conclusions and provide further evidence on the comparative performance of BSM strategies.

Two significant contributions to the existing literature may be pointed out. Although there has been a substantial amount of theorizing on appropriate tools for BSM, we are not aware of any systematic treatment of BSM strategies. Our categorization establishes a basis for specifying and comparing BSM strategies. In addition, linking the categories to fundamental questions in financial theory allows a normative conclusion regarding the appropriate BSM strategy – contingent on the risk philosophy of a bank's management. From the perspective of a bank analyst, the observation of a specific BSM strategy offers insight into the risk philosophy of a bank's management.

The second contribution of this paper is the introduction of a research design to empirically test and compare the longitudinal performance of BSM strategies. Since the model only requires a limited number of input parameters, we believe it is flexible enough to allow a wider adoption for similar studies. As we base our model on historical data, the crucial assumptions regarding the (joint) distribution of key variables are already included in the data. Finally, due to similar business models, we regard the empirical results as representative for a broad class of mid-sized commercial banks.

End Notes

1 The terms «asset-sensitive» balance sheet and «positive balance sheet gap» are used synonymously throughout this paper. The opposite terms are «liability-sensitive» and «negative balance sheet gap».

2 While borrowers prefer variable-rate mortgages due to their moderating impact on the variance of real income, lenders favor variable-rate mortgages in order to match the duration of short-term deposits and thus to protect themselves against a rise in interest rates.

3 Since shareholders are often not a homogenous group, *Kürsten/Meckl/Krostewitz* (2007) propose a framework to distinguish more precisely between the different claims and stakes of the major shareholder groups.

4 This study is based on the repricing gap profile of assets and liabilities. The economic capital measure «duration» is only used to characterize specific strategies. In this context, it can be thought of as the weighted average repricing date of the «equity investment.» We do not use duration as a measure to determine the hedge portfolio.

5 Please note that the definition of the term «economic capital» is different from the usual definition of banking regulation.

6 Please note that the choice of parameter values (within a reasonable range) does not affect the qualitative results of our analysis.

7 The Swiss cantonal bank replicated products with embedded options (e.g. variable-rate mortgages or customer deposits) with a constant maturity bond approach. Please refer to *Burger* (1998) and the references cited therein for a detailed description of this approach.

8 The DCC specifies the number of days each month or year has, which is then used as the basis for calculating the interest income of a swap for a particular period.

9 While the Swiss cantonal bank separately reported the income of the swap portfolio, we have only been provided with an aggregate repricing gap profile. Thus, we cannot draw any conclusion regarding the impact of the active element of the hybrid BSM strategy on the economic capital risk exposure.

Appendix

Unleveraged Benchmark Strategy[2]	Low Duration[4]				Medium Duration[4]						
Investment Horizon (Years)[1]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12.5**
Net Interest Income (CHF million)[5]	18.7	19.3	19.7	20.0	20.2	20.3	20.5	20.5	20.6	20.7	20.8
Volatility (CHF million)[6]	2.52	2.37	2.10	2.12	2.08	2.15	2.17	2.18	2.20	2.21	2.22
Duration[7]	0.5%	1.0%	1.5%	1.9%	2.4%	2.8%	3.2%	3.7%	4.1%	4.5%	5.0%
RORAC[8]	23.0%	23.8%	24.5%	24.9%	25.2%	25.3%	25.4%	25.5%	25.6%	25.7%	25.7%

100% Leveraged Benchmark Strategy[3]	Medium Duration Leveraged[4]						High Duration Leveraged[4]				
Investment Horizon (Years)[1]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12.5**
Net Interest Income (CHF million)[5]	na	21.0	21.5	22.1	22.4	22.6	22.7	22.9	23.0	23.1	23.2
Volatility (CHF million)[6]	na	2.60	1.89	2.13	2.15	2.37	2.45	2.51	2.56	2.62	2.64
Duration[7]	na	2.4%	3.3%	4.2%	5.0%	5.8%	6.6%	7.4%	8.1%	8.8%	9.8%
RORAC[8]	na	25.7%	27.0%	27.5%	27.8%	27.9%	28.0%	28.1%	28.2%	28.3%	28.3%

Note: (1) The investment horizon defines the maturity spectrum, over which the portfolio equity is invested. (2) The unleveraged benchmark strategy involves investing a constant proportion of the portfolio equity across the investment horizon. (3) The 100% leveraged benchmark strategy involves borrowing 100 percent of the portfolio equity on a 6-month roll-over basis and investing the additional capital along with the equity across the investment horizon. (4) Low duration strategies are defined to have an absolute modified duration of less than two percent, medium duration strategies between two and six percent, and high duration strategies more than six percent. (5) The net interest income is the average monthly net interest income over the simulation horizon, spanning from February 2000 to April 2006. (6) The volatility is defined as the standard deviation of the monthly net interest income. (7) The duration figure is computed as the average absolute modified duration. (8) The RORAC figures are calculated based on Equation 2 with F = 10 and R = 8%.

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