INTRODUCTION

Non-maturing liabilities (such as saving accounts and current accounts) are a major source of funding for many retail banks and a much envied source of liquidity for their Commercial- or Investment-banking peers. Yet characterizing, quantifying and ultimately hedging the interest rate risks of such instruments has, for long, proven quite challenging.

In this paper we illustrate how a replicating portfolio approach can offer a pragmatic solution to address this point. In addition a practical case study is presented based on the average base rate on Belgian regulated saving accounts. The results suggest that historically some banks making over-simplistic assumptions may have ended-up not only making materially less margins but also have increased the volatility of such margin and hence their related interest-rate risks.
**METHODOLOGY**

To determine the duration of non-maturing assets and liabilities we propose to use a replicating portfolio approach. This approach consists in determining the portfolio of fixed income securities and the related investment strategy that best replicate the cash-flows of the non-maturing liabilities. The duration of these non-maturing liabilities is then determined as the duration of this replicating portfolio and can be computed analytically. Such method, usually referred to as a Static Replicator, is commonly used by larger Belgian banks (as one of our surveys recently showed) and has already been described in several academic papers in the past. In contrast with most papers we use a simulated based calibration procedure which allows giving a richer picture of the risk and returning trade-off.

**Replicating Portfolio Concept**

In a Static Replicator approach, the portfolio of fixed income securities is defined as a buy-and-hold portfolio of “risk-free” zero-coupon bonds. These instruments are initially distributed across different maturity buckets and “move” through the maturity ladder until they are redeemed. The nominal amount which is redeemed at a given point in time is directly reinvested in a limited number of maturity buckets (also call “reinvestment buckets”). The reinvestments are performed using a fixed allocation rule (the “reinvestment rule”) whereby for each reinvestment bucket different reinvestment weights are assigned.

**Calibration**

The objective of the calibration is to determine which reinvestment rule most effectively replicates the cash-flows of the non-maturing liability (for instance, we aim at finding the zero-coupon reinvestment rule which would have best replicated the interests paid on saving accounts).

In such approach it is critical to define what is meant by “most effectively replicating the cash-flows”. In recent surveys we conducted among Belgian banks, we found that most institutions aim at minimizing the variability of the modeled interest margin (i.e. the difference between the cash-flows perceived from the replicating portfolio and those paid-out on the liabilities to be replicated). Practically this is translated in minimizing the standard deviation of the interest margin over a historical time period considered. This will also be the approach in this document.

We follow a simulation based approach for solving this minimization problem. This approach consists of three steps and is schematically illustrated in Figure 1:

1. First, a large set of potential reinvestment rules is generated. We thereby make sure that these rules cover the entire universe of potential rules.
2. Second, for each reinvestment rule we simulate the composition of the replicating portfolio and its portfolio rate over the historical time window chosen for the calibration.
3. Finally, the optimal reinvestment weights are determined by focusing on the reinvestment rule that results in the most stable margin between the portfolio rate and the non-maturing instrument rate.

The advantage of this simulation-based method is that it allows us not only to determine the optimal replicating portfolio weights, but also to construct the entire risk/return plane which may reveal additional useful information. For investment decision purposes banks might for example not only be interested in the minimum volatility portfolio, but also in the portfolio with the highest Sharpe ratio (measured as the average margin divided by the standard deviation of the margin – See footnote above). Traditional optimization techniques like OLS regression do not provide such a rich view on the interest rate risk of the financial institution.

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2 Alternatively, some banks may rather aim at optimizing “Sharpe Ratio”-like metrics such as the Average Interest Margin divided by its volatility.
3 OLS = Ordinary Least Square
Reinvestment of free cash flows (from client activity and bonds coming at maturity) are simulated using a fixed reinvestment rule.

The replicating portfolio allocation is the theoretical buy and hold portfolio of bonds that results from applying the reinvestment rule over time.

The evolution of the replicating portfolio is simulated historically (given on the time series of financial market rates and deposit rates).

The optimal reinvestment rule is chosen so that the variance of the interest margin is minimized.
CASE STUDY

In this section we present the results of a case study when the approach is applied to the average saving account rate in the Belgian retail market.

Data & Model Choices

The average rate on regulated saving accounts for the Belgian retail market is available on the website of the National Bank of Belgium (NBB)\(^4\).

It is important to point out that for this case study we will only use the base rate as an indicator for the saving account rate. In real-life Belgian Saving Accounts would typically pay both this base rate and a fidelity premium whose rate cash-flows depend on the time the deponent has left the amounts on his saving account. Since there is uncertainty on the payout level of the fidelity premium we have excluded this element.

When developing ‘real-life’ replicating portfolio models and applications for banks we typically also include this fidelity premium in our model by accounting for the specific cash-flows it generated.

Figure 2 presents the evolution of the average saving account base rate. For illustrative purposes the evolution of the short term (3M EURIBOR rate) and long term (5Y EUR swap rate) “risk-free” interest rate have also been included.

The data is available on a monthly basis from 01/2003 to 04/2013. In order to align ourselves with the data frequency, we choose to work with monthly maturity buckets and to simulate the portfolio composition in monthly time steps.

The following reinvestment buckets were chosen: 1M, 2M, 3M, 6M, 1Y, 2Y, 3Y, 5Y, 7Y, 10Y. For the optimization we have used a set of 10,000 randomly generated reinvestment rules.

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\(^4\) [http://www.mfiir.be](http://www.mfiir.be)
Results

The risk/return plane of the 10.00 investment rules that were tested is presented in Figure 3. Each point in this plot represents a reinvestment rule. The x-axis represents the historical standard deviation of the margin while the y-axis represents the historical average of the margin of the resulting portfolios. The colors of the points represent the average duration over the calibration window of the resulting portfolios.

Figure 3

At the one end of the spectrum we observe a number of portfolios with a very low duration. These portfolios invest exclusively in 1M to 3M bonds and as a result their average return or margin is low. Since the short term interest rates tend to move much faster than the saving account rate, the risk on the margin is high.

At the other end of the spectrum we observe a number of portfolios with a high duration. These portfolios invest exclusively in 7Y and 10Y bonds and as a result their average return or margin is high. Since the long term interest rates tend to be more stable than the saving account rate, the risk on the margin is also high.

The optimal replicating portfolio is situated between these two extreme cases.

From figure 2 we can see that all portfolios with a low risk on the margin (the left hand side of the plot) have duration between 2Y and 3Y. The portfolio with the lowest margin volatility turns out to have an average duration of 2.9 years. Over the observed historical time period, for this ‘optimal’ replicating portfolio, the average margin amounts to 1.88% and the standard deviation of the margin amounts to 0.30% for this portfolio. The following table presents the reinvestment weights:

<table>
<thead>
<tr>
<th>Reinvestment Bucket</th>
<th>1M</th>
<th>2M</th>
<th>3M</th>
<th>6M</th>
<th>1Y</th>
<th>2Y</th>
<th>3Y</th>
<th>5Y</th>
<th>7Y</th>
<th>10Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinvestment Weight (%)</td>
<td>6.00%</td>
<td>20.89%</td>
<td>48.76%</td>
<td>0%</td>
<td>17.29%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>7.06%</td>
</tr>
</tbody>
</table>
Replicating Portfolio Approach to Determine the Duration of Non-Maturing Liabilities

The evolution of the replicator rate and the saving account rate over time are presented in Figure 4. We observe that both rates move relatively closely in parallel, which results in stable margin.

Figure 4

![Average Belgian Saving Account Rate vs Portfolio Rate](image)

Comparisons with typical assumptions used by smaller Belgian banks

For the purpose of Regulatory Risk reporting, the National Bank of Belgium (NBB) suggests using a 2 year duration assumption for traditional Belgian retail saving accounts. As a result several smaller banks will also use such 2Y-duration assumption in their ALM for the purpose of interest rates hedging. Our analysis suggests that such a short-cut assumption would historically have contributed to a lower Net Interest Income (NII) while also increasing its volatility (see Figure 5).

We however need to point out that all results presented here are off-course highly dependent on the historical time period that was chosen for the calibration. This raises the question to what extent these findings are relevant for an environment characterized by increasing & steepening rates. In the next sections we will present a number of extensions to the model used in this case study. One of these extensions consists in introducing forward-looking simulated scenarios for the calibration, in order to overcome the limitations of using a single historical scenario.

Figure 5

![Historical Average margin vs Historical Standard deviation of margin](image)
POSSIBLE EXTENSIONS

We believe the methodology described in this paper calls for several extensions.

First, it is possible to apply constraints on the reinvestment weights. In practice financial institutions need to keep a buffer of liquid short-term assets for liquidity risk management purposes. As a result, the optimization should only be performed for a part of the portfolio (the so-called ‘core balance’). This constraint can be included in the model by assigning a minimum weight to the short term reinvestment buckets.

Secondly, we present here static replicating portfolio techniques only. A few banks may also consider more dynamical investment strategies that allow adapting reinvestment rules for more volatile interest rates environments or shapes of the yield curve. Again, our methodological approach allows including to relatively straight-forwardly formulaic rebalancing strategies.

Thirdly, banks that actively manage the duration of their bond portfolios when the duration gap between what they estimate the best estimation duration is and the duration assumption under which they have to report widens too much may account for such strategy in their replicator. Basically these consist in duration-driven rebalancing which can easily be modelled in the replicating portfolio investment strategy. In such case the objective of the replicator is then somewhat different: rather than aiming at determining the duration of the non-maturing liabilities, the bank seeks what is, given a pre-assumed duration of these liabilities, the optimal investment strategy to replicate such duration.

Last but not least (and maybe most importantly), in the calibration approach above the optimization of the reinvestment weights is based on a single historical scenario, which can introduce a bias in the results. For instance, the recent history is characterized by an ‘in-average’ lowering & flating rate environment which strongly impacts the results. Alternatively, our methodology can also be used in combination with a set of hypothetical scenarios generated by stochastic interest rate models (such as the Hull-White or CIR2++ model) which are often found in the forward-looking Economic Scenario Generator (ESG) of banks or insurance companies.
CONCLUSIONS

Our observations for the average Belgian base-rate on regulated saving accounts suggest taking 'naïve' assumptions for the duration of its non-maturing liabilities could drive a bank not only to make less profits but also to become more risky.

Having applied our methodology to a set of particular cases at different banks in the Benelux (then taking into account more precise information such as fidelity premiums, effects on non-constant saving volumes over time, duration-driven rebalancing strategies, forward-looking scenario’s, etc.) we have often come to the same findings and could observe that the adverse differences where material and long-lasting.

We thus advocate that retail banks should aim at quantifying robustly the duration of their non-maturing liabilities taking into account their very-specific business cases (i.e. pricing policy, clients-segments behaviors, type of accounts, etc.).

Here for, we believe the replicating portfolio approaches offer pragmatic, transparent and easy to implement solutions.

TEST IT YOURSELF

To illustrate this article we have put on-line a web-based version of our Static Saving Account Replicator as described in this document.

It uses the same data sample and will allow you to replicate our results.

It will also enable you to test the approach using different assumptions for the composition of the replicating portfolio and use an alternative optimization criterion (Sharpe-ratio like).

Finally results can be downloaded in Excel format to illustrate how simply our proposed solutions could be implemented even if a bank prefers to fully outsource the model development, running and maintenance.

Our illustrative on-line replicator is available on:

http://spark.rstudio.com/wkonings/WhitePaper

Watch out: calculating the maximum number of simulations (10,000) can take up to a few minutes depending the availability of the server.
HOW REACFIN CAN HELP

Reacfin has recently spent substantial efforts in developing an extensive set of robust & readilyusable tools & methods aimed at supporting banks optimizing their active risk management of non-maturity assets & liabilities.

Our solutions range from off-the-shelf calculation tools such as replicating portfolio models and ESG’s to tailored developments including bespoke calibrations, implementation processes and optimizations methods through state-of-the-art consulting services.

A few examples of practical solutions include:

- Simple Excel based model for basic Static Replicating portfolio models with a wide range of tools to link these spreadsheet to your existing FTP\(^5\) framework and NII\(^6\) calculations
- Advanced Replicator Models in R or other mathematical languages
- Advanced economic scenario generator
- Online solutions which enable you to partly outsource the calculation and maintenance of your replicating portfolio

Furthermore, several of our consultants have gained substantial real-life experience developing similar models in various environments which, combined with our disciplined assessment methodologies and frameworks, allow us to offer state-of-the-art services to benchmark, review or validate the models you may have developed in-house.

CONTACT DETAILS

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\(^5\) FTP = Fund Transfer Pricing

\(^6\) NII = Net Interest Income
About Reacfin

Reacfin is a consulting firm focused on setting up best quality tailor-made Risk Management Frameworks, and offering state-of-the-art actuarial and financial techniques, methodologies & risk strategies.

While we initially dedicated ourselves to the financial services industry, we now also serve corporate or public-finance clients.

Advancements in finance and actuarial techniques are developing at a fast pace nowadays. Reacfin proposes highly-skilled and experienced practitioners, employing innovative techniques and offering expertise in compliance and risk strategies & governance. Our support will allow your firm to reach top performances and gain new competitive advantages.

As a spin-off from the UCL (University of Louvain which ranks eighth in the world for master’s degrees in insurance), we maintain a strong link with this institution which enables us to give independent, tailored and robust advice on risk management, actuarial practices and financial models.

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