International Journal of Financial Management
8 (2) 2018, 32-42
http://publishingindia.com/ijfm/

Measurement of Total Liquidity Assets Risk Resulting from Increase of Liquidity Spread

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Abstract

The importance of analysing the effects of changes in liquidity spreads for long maturities on both costs and wealth increases with the increasing importance of capital market-based refinancing by banks. The present study proposes a present value based approach for middle-sized banks. It enables to measure the impact of the extreme change in the institution's own liquidity and spreads on the current liquidity situation by investigating the entire maturity horizon to a dangerous extent. Different scenarios for refinancing alternatives due to the different developments of the liquidity spreads can be analysed straightforwardly. This enables a rapid assessment of the risk situation over the modelled time. In the dynamized version, which covers the planning horizon, the interest rate effects arising over time are also made visible. The result of the model approach is suitable for strategic decisions in planning the refinancing structure under alternative conditions.

JEL Codes: C18, C81, G21, G28, G17

Keywords: Banks, Basel III, Liquidity Risk, Liquidity Spread, Present Value, Stress-Testing

Introduction

With the outbreak of the financial crisis of past decades, refinancing costs rose dramatically due to the massive widening of credit spreads for banks. As a result, banks were unable to acquire financing at reasonable cost (Bellini, 2017; ECB, 2016, pp. 36, 38; Rudolph, 2010). The liquidity spread, defined as the difference between the institute's return on own issues and the swap curve, is significantly influenced by different constellations of the market situation (Krones & Cremers, 2012; Neu, 2007). As has been observed, with rising of credit spreads, liquidity spreads are widening as well. This situation can also occur irrespective of the creditworthiness of the respective bank (Neu, 2007). The widening of liquidity spreads over longer periods has a strong impact on income from liquidity maturity transformation (LMT). The change in the liquidity spread curve should therefore be modelled under different scenarios.

The aim of management structural liquidity, often known as "funding" or long-term liquidity, is to ensure compliance with the legal requirements on liquidity (in Germany §11 KWG) and to optimize profitability by determining and ensuring a minimum-cost refinancing mix (Barteztky, 2010; Pohl, 2008). Fluctuations in refinancing rates on the money and capital markets should have the least possible impact on earnings. The LMT risk represents the risk of loss arising from changes in the bank's own refinancing curve, i.e., the liquidity spread curve, resulting from the LMT within a given time period at a certain security level (Bartetzky, 2010).

The impact of credit spread widening is evident on both sides of the balance sheet: on the assets side, it leads to a fall in asset prices; on the liabilities side, it leads to an increase in the costs of raising liquidity on the money and capital markets. Not only long maturities, but also large business volumes are affected. The asset-side risk is generally taken into account as a part of market-risk measurement. However, as the LMT risk has a similar effect on earnings as other price risks, it is important to monitor the effects of changes in spreads on both sides of the balance sheet at the same time (Bartetzky, 2010). The classification of liquidity risk as an inability to meet current or future payment obligations as they come due and the LMT risk has an impact on risk coverage, the choice of control methods, and the structure of stress tests.

This paper addresses this problem by presenting a stress-test model for quantifying liquidity costs, whereby the

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regulatory requirements for medium-sized banks are considered. Most banks perform liquidity-gap analysis for different time horizons on a qualitative basis. Measuring the LMT risk by using modern methods is not common yet. At present, no mature methods and procedures for controlling and measuring LMT risk have been established.

The present work closes this gap and focuses on LMT risk. The approach is designed to cover the entire maturity horizon and provides the risk as a change in the present value (PV) of liquidity assets resulting from a liquidity spread change due to a distress. It consists of two parts: The static-scenario analysis starts at the current observation time-point and shows the total value of liquidity assets. The dynamic-scenario analysis determines the PV on the planning horizon and thus considers the development of the position and the yield curves over time. The stress-testing procedure is illustrated in the case study with a fictitious German middle-sized bank.

The aim of the present work is to develop an approach that can be used in practice in medium-sized banks active in the capital markets. They are not small enough to benefit from the principle of proportionality (EBA, 2017, p. 4). They usually have a business structure for which copious and complex models are unsuitable; for example, maintaining of mathematical and methodological expertise and IT. Banks are facing the excessively increased liquidity-risk-regulatory requirements of Basel III and SREP as ICAAP/ILAAP (EBA, 2016). They have to implement risk-quantification methods, for both Pillar 1 and Pillar 2 risks, fitting to their business models and risk profiles. A bank should be viable in times of crisis by looking at the current and prospective capital and liquidity sources and needs. Stress testing guidelines are going to be finalized in 2018 by EBA. The circumstances currently prevailing in banking practice therefore call for a stress-test concept that builds on existing procedures using modern approaches and allows for prudent liquidity cost estimates under various scenarios. The model should meet the following requirements:

- comprehensibility
- flexible configuration of scenarios
- use of well-known methods of low complexity
- expandability
- meeting regulatory requirements

Related Literature

The present study draws on the literature that relates to Matz (2011) and Neu (2007) who view the liquidity risk as a consequential risk, because it increases following one or more spikes in other financial risks. The definition of funding liquidity risk leans on Drehmann and Nikolau (2009) understanding as a flow concept with two risk components: the future random cash flows (CF) and prices for acquiring funding from different sources. It is in line with the definition of LMT risk as Bartetzky (2010) determines. Bai, Krishnamurthy, and Weymuller (2017) construct a liquidity mismatch index to investigate the mismatch between the market liquidity of assets and funding liquidity of liabilities. LMI-stress test offers an early warning of banking-sector fragility.

As Fiedler (2007) states, the structural liquidity risk can be measured with a LGR analysis. He measures the value liquidity at risk as a possible change in the discounted value of the changed CF and shows the management of limiting risk by using expected CF. Schmitt (2017) extends the determination of the LGR by considering of non-contractual and behavioral CF and the counterbalancing capacity (CBC) and proposes a comprehensive LGR that is an appropriate base for liquidity and wealth evaluation and stress testing.

According to Khan et al. (2015), bank size and capital buffers may affect the relation between liquidity risk taking and costs of funds. The present study leans on two principles for understanding liquidity costs, as Neu (2007) determines: (1) dependence on scenario, market conditions, bank balance sheet, and bank's positioning on the market, (ii) liquidity reserve reduces liquidity risks, but increases liquidity costs. In the study of Galiay and Maurin (2015) of the post-crisis regulatory package and synthetic estimation of risk, the authors show that bank's market funding costs are affected by the regulatory changes and the capital for funding and liquidity regulation has a dampening effect. Schupp and Silbermann (2017) answer the questions of whether a stable funding makes German banks safer and reduces the probability of financial distress.

The PV calculation of liquidity costs is based on Pohl (2010). He presented a liquidity equalization procedure, where only negative marginal liquidity gaps in the LGR are closed up (by adequate compensation transactions) to the time point from which compensation through positive liquidity gaps occurs. The calculation of refinancing transactions is on a retrograde basis, the costs of the resulting liquidity needs are determined by discounting and using the institute's own liquidity spread. In the present study, this approach is modified and extended for use in a middle-sized bank. The decisive advantage of the extended method is that the cash-flow-related liquidity risk is included in the risk calculation because only the refinancing costs resulting from the LGR are explicitly determined.

Methodology and Data

Figure 1 illustrates the components of the present stress testing model approach.

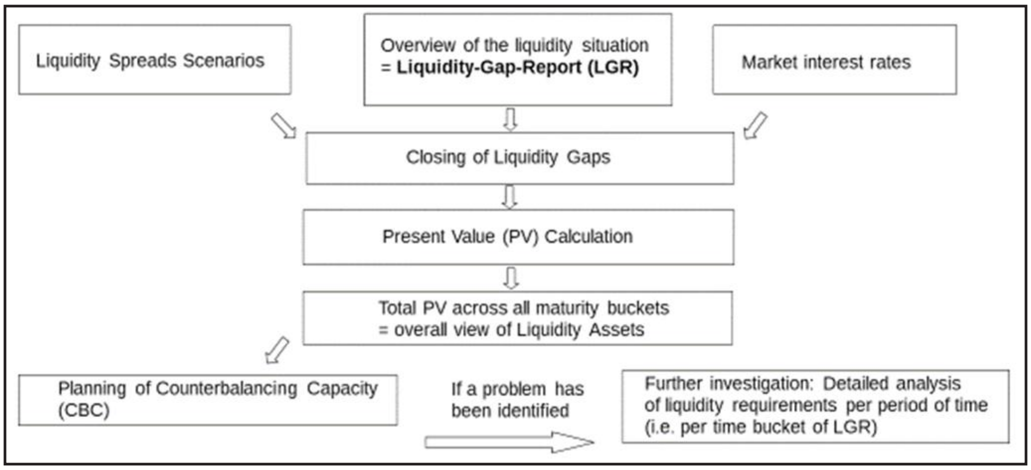

Fig. 1: Stress-Testing Model Approach: An overview[1]

[1] Source: own proceedings.

Liquidity gap report

LGR shows an overview of the liquidity situation for different time horizons from the observation time-point.[2] Therefore, it is a suitable forward-looking tool (CEBS, 2009). The future payment balances, i.e., the liquidity gaps, can be determined by a structured comparison of incoming and outgoing payments:

$$NCF_t = ECF_t^+ - ECF_t^- \;\; for\; t = 1, \ldots, T \tag{1}$$

where NCF_t is the marginal liquidity gap in the respective time-bucket t, $ECF+$ is the sum of all expected cash-ins, and $ECF–$ is the sum of all expected cash-outs (Schmitt, 2017).

[2] How to build a comprehensive LGR does not belong to the scope of this article. For more details, confer CEBS (2009), Matz (2011), Pohl (2008), and Schmitt (2017).

Liquidity Spread

In practice, different terms are used for credit spreads, depending on the underlying reference interest rate (Gann, 2010; Krones & Cremers, 2012; Schlecker, 2009).

Spread over swap or liquidity spread is the difference between the spot rate curve of corporate bonds (institute's own issues) in a respective rating class and the swap curve.

Determination of Liquidity Risk Costs

Calculation of Costs from the Closure of Liquidity Gaps

In order to calculate the costs or income incurred in closing the liquidity gaps, the LGR must be balanced in such a way that the interest book management is not changed, other risk types are not affected, and no undesirable effects on the balance sheet structure occur. Each gap is compensated by a suitable money and capital market transaction.[3] The fictitious closing transactions generate fictitious interest-costs or interest-income, depending on whether a positive or negative gap is closed. When negative gaps are closed, i.e., for the purpose of acquiring liquidity, the bank pays its current refinancing-price on the capital market, which is expressed by the bank's own liquidity spread. On the other hand, it can make an investment from closing the positive gaps at the current market interest rate.

The interest payments, Y_t, are calculated (in the maturity bucket t) as:

$$Y_t = \begin{cases} NCF_t \cdot (refinancing\ interest\ rate), & for\ NCF_t < 0 \\ NCF_t \cdot (market\ interest\ rate), & for\ NCF_t > 0 \end{cases} \tag{2}$$

The refinancing-interest-rate is determined as:

$$RY_t = Swap_t + LS_t + \Delta LS_t \tag{3}$$

$Swap_t$ = reference curve (here: swap curve), swap rate for the maturity bucket t,

LS_t = institution-specific liquidity spread in the maturity bucket t,

ΔLS_t = Difference between the base liquidity spread and the scenario-based liquidity spread ("delta liquidity spread") in the maturity bucket t. In the base case is $\Delta LS = 0$.

Such an amount of the fictitious costs or earnings depends on the gap amount, the change in the interest rate structure, and the changes in the liquidity spread. The potential movements of the liquidity spread are determined using stress scenarios. Depending on the evaluation target, the gap can be closed retrogradely or prospectively.

Selection and Design of the Stress Test

The selection of appropriate stress tests must be based on prevailing market conditions and the bank's business and risk strategy. More attention should be paid to the integration of specific ad-hoc stress tests adapted to the situation (CEBS, 2009; EBA, 2017; Matz, 2011). The central question is which critical situation is most likely to occur in the current environment.

At least the following scenarios based on the existing business portfolio, i.e., the cash flow development of the actual situation under normal market conditions, should be calculated. In the present study, the basis scenario and the scenario 1 are calculated exemplarily.

Basis scenario: Development of interest rate and liquidity spread as under normal market conditions. This scenario represents the basis for comparison of the respective changes.

Scenario 1: (Institute's own scenario) Parallel shift in the liquidity spread (sensitivity analysis) upwards and downwards based on empirical observations of market-induced changes in the institute's own liquidity spread.

The absolute change in the liquidity spread is determined as the mean value from the maximum or minimum changes in the time-series values at three grid points—1 Y, 5 Y, and 10 Y—of the respective liquidity spread curve. The value of the liquidity spread at the observation time-point on each grid point will increase or decrease by the shift-value. Result is the new scenario-based liquidity spread structure curve.

Scenario 2: (Market scenario) Structural change in the liquidity spread (sensitivity analysis) based on historical development. The magnitude of the change is measured at each grid point within the selected time-series. The maximum/minimum change value will be added to the value at the observation time-point.

Present Value-Oriented Calculation of Liquidity Risk

The liquidity gaps changed by the closure costs/earnings see section "Calculation of costs from the closure of liquidity gaps". are used for the PV calculation. The modelling of the following two facts enhances Pohl's (2010) approach:

Observation horizon: Risk measurement is to be carried out from an overview of the liquidity portfolio from the current view and information available. In the present model, the interest rates are used according to the remaining term from the current point in time.

[3] Because of the interest rate risk, the fictitious transactions should have a variable form. It is advisable to use forward contracts. From the modelling point of view, they represent a consistent solution for the calculation of fictitious costs. A suitable instrument for closure of liquidity gaps is the issuance of floating-rate-notes.

PV calculation itself: As shown in the following paragraph it answers the question of how the scenario would affect current circumstances if the liquidity spreads were to change suddenly.

Steps for Calculation Liquidity Costs

Part 1. Determination of the Calculated Liquidity Costs

Step 1: Basic data: The marginal liquidity gaps (NCF_t) are displayed per maturity bucket t from the LGR created for the selected scenario. (Here: The LGR is modeled for a basis case – the normal market conditions.) The following data are required for cost calculation:

- the reference curve to which the institution's own liquidity spread is applied (e.g., swap curve),
- the institution's specific-liquidity spread curve, under normal and stress conditions,
- the yield curve for discounting

Step 2: Suitable countertrade transactions for closure of the open liquidity gaps are to be found in accordance with (2) and (3). This procedure is carried out retroactively for each maturity bucket. It starts with the last one and continues until the entire LGR is closed (Schmitt, 2015).

Step 3: After interest payments were calculated for all closing transactions, they would be summed up per maturity bucket and offset against the corresponding NCF_t. This results in a time series of the liquidity balances LiS_t (i.e., the new liquidity needs or surpluses) across all maturity-buckets:

$$LiS_t = NCF_t + GY_t \qquad for\ t = T, \dots, l \quad maturity\ buckets \tag{4}$$

$$GY_t = summed\ values\ of\ Y_t\ in\ the\ maturity\ bucket\ t,\ and \tag{5}$$

$$GY_T = 0,\ \ i.e.\ \ there\ are\ no\ interest\ payments\ in\ the\ last\ maturity\ bucket\ \ T$$

Part 2. Calculation of the Scenario Present Value

Step 4: The relevant zero bond discount factors (ZBDF) are calculated based on the asset swap curve. Discounting is based on the assumption that the general interest rate level does not change in the liquidity-stress situation. In contrast, only the specific liquidity spread level changes. Hence, the stress scenario is viewed in isolation. The idea for this approach is based on its practical benefit: it provides a clear presentation of the results and thus considerably simplifies the communicability of the results to the management levels.

In order to calculate the present value of the liquidity assets of the respective maturity bucket at the current observation date, it must be discounted using the corresponding $ZBDF_t$, i.e.,

$$PV\ LiS_t = LiS_t \cdot ZBDF_t \qquad for\ \ t = 1, \dots, T. \tag{6}$$

Step 5: The liquidity assets (capacity) for the entire maturity spectrum is calculated as the sum of the present values of the liquidity assets of the individual maturity bucket t:

$$PVGes = \sum_{t=1}^{T} PV\ LiS_t. \tag{7}$$

This present value (PV) represents the amount, the PV return of the income or expense required by the bank to close its open liquidity positions across all maturity buckets at the current (observation) time-point and at current market conditions.

However, the interest of the stress-testing evaluation lies in calculating the extent of the effects of a modelled scenario as if it occurs at the current observation time-point. Hence, it is necessary to calculate the PV for the basis case and the stress scenario according to the earlier steps. The difference between these PV represents the risk that would arise if the bank's refinancing conditions, i.e., the bank's own liquidity spreads, would change over the entire period.

$$PV_{Stress} = \Delta PVGes = PVGes_{Stress} - PVGes_{Basis} \tag{8}$$

Static Scenario Analysis

The aim of this approach is to determine the risk of scenario-based changes in total liquidity assets at the current valuation date. Different refinancing strategies in combination with selected, modelled liquidity spreads are to be investigated in a descriptive manner for the entire maturity spectrum. The regulatory requirement to identify a liquidity shortfall for different scenarios of changes in the liquidity spread is met. Due to the clear calculation method, it can be quickly assessed whether the liquidity need is increasing into a threatening dimension.

Dynamic Scenario Analysis

The aim of the dynamic analysis is to plan the refinancing from a future point in time. The focus is on taking into account the interest rate effects that arise over time. The total liquidity assets are calculated on the planning horizon of 1 year. For this reason, the forward curve is used for the calculation, the grid points of which are determined from the yield curve for the time in a year that is current at the time of valuation. The sideways movement of the current spread is assumed. As the effect of the runtime reduction occurs, this value of liquidity assets differs from that at the current time of analysis.

The PV calculation of the liquidity costs from the closing transactions of the open liquidity gaps in the dynamic analysis is carried out in the same way as for the static scenario analysis.[4] The new development consists of two points: Shortening the LGR and calculating the cost of capital in the first year. The valuation process is carried out through the following steps:

- The LGR is reduced by 1Y maturity bucket to show the liquidity situation in 1 year: the first year is represented by the second year of the original LGR, and so on.
- The PV of liquidity assets in 1 year is calculated in accordance with the procedure in the static scenario analysis. It represents the liquidity assets in 1 year.
- The liquidity assets from investments or refinancing in the first year are calculated separately. Negative liquidity balances are calculated based on current refinancing conditions, whereas positive liquidity balances are calculated at the market interest rate of the corresponding capital commitment stage.
- The PV of liquidity assets in 1 year and the costs of the first year are added together in order to maintain all liquidity assets at the planning horizon. The reason for this procedure is to gain a strategic view of the planning of the refinancing structure if the time of observation lies in the future.

[4] The prolongation of the observation date by new transactions was not examined here.

Hypothetical Bank and Its LGR

The basis for developing meaningful stress tests the bank's strategic orientation and its economic environment is regarded. In the present case study, a simplified hypothetical structure of a middle-sized German bank is chosen. It has a hypothetical balance-sheet total of approximately 35 Billion Euro, where the asset side includes 74% lending to non-banks, 8% lending to banks and 15% bonds, and the passive side includes 40% debt securities, 30% non-bank-deposits and 20% bank-deposits.[5] Typically, such banks are mortgage banks and some saving banks, which also use capital markets for refinancing. They issue own bonds such as covered bonds – "Pfandbriefe". To determine the hypothetical LGR, it is assumed that the balance sheet is constant and the business model remains stable (Schmitt, 2017; assumptions according to EBA, 2017, p. 14, point 5 have been complied with). The time-bucket structure is oriented on the calendar days and arranged as follows: nine time-buckets for the first to ninth year and one time-bucket for all businesses with maturities 10 years and longer. The currency used is Euro.

Table 1 shows the hypothetical marginal liquidity gaps.

[5] The hypothetical bank was prepared on the base of the current schedule: http://www.die-bank.de/fileadmin/pdf/die-bank_8_2016_TOP100_web.pdf and annual reports of 2016 of selected banks with the balance sheet total in the range of 31 – 43 Bio. €.

Table 1: Marginal Liquidity Gap of the Hypothetical Bank for the Base Case[6]

Maturity	*1Y*	*2Y*	*3Y*	*4Y*	*5Y*	*6Y*	*7Y*	*8Y*	*9Y*	*10Y*
NCF_t	-569	-280	-390	-390	-585	390	650	195	260	910

[6] Source: own proceedings. Source of market data as referenced in the section "Market Data"

Market Data

The hypothetical liquidity spread is derived from two interest rate curves, on the monthly closing base, from 01/2000-10/2017:

- As a proxy for the institute's own financing curve, the "Pfandbrief" historical yield rates, as in the time series statistics of Deutsche Bundesbank are used.[7] Swap curve as a risk-free reference.[8]
- The zero curve is computed from the swap curve, by using the bootstrapping method. It is used for determining the discount factor.

[7] www.bundesbank.de/Navigation/DE/ Statistiken/Zeitreihen_Datenbanken/Geld_und_Kapitalmaerkte/geld_und_kapitalmaerkte_list_node.html?listId=www_skms_it04b.

[8] Asset Swap, financial, Euro, rates: Bloomberg.

Table 2 shows the rates for the basis case:

Table 2: Market Data for the Base Case, at the Observation Time Point 31.10.2017[9]

Maturity	*1Y*	*2Y*	*3Y*	*4Y*	*5Y*	*6Y*	*7Y*	*8Y*	*9Y*	*10Y*
Swap %	-0,266	-0,198	-0,078	0,058	0,199	0,336	0,472	0,5939	0,726	0,8355
Zero %	-0,266	-0,198	-0,078	0.0582	0,2001	0,339	0,4772	0,6022	0,7391	0,8535
LS (BP)	15,59	10,75	6,8	4,2	3,1	4,4	4,8	6,61	7,4	8,45

[9] Source: own proceedings. Source of market data as referenced the section "Market Data".

Results and Discussion

Risk Assessment

The risk assessment is carried out as a case study in accordance with the steps shown in the section "Determination of liquidity risk costs" basic and stress scenario. The starting point for the PV calculation of liquidity assets is the marginal gap, NCF_t, scenario liquidity spreads, calculated in accordance with the section "Calculation of costs from the closure of liquidity gaps". scenario 1, and market rates, as shown in Table 2.

Static Scenario Analysis

As shown in Table 3 for the basis case, the marginal gaps are closed retrogradely, starting with NCF_{10Y}. In each time bucket, the closing costs/earnings are calculated and added to the respective NCF_t. In this order, the first time-bucket where the liquidity needs of -585 Mio. € appear is 5Y. The costs/earnings of balancing transactions in previous time-buckets 10Y-6Y are added to the NCF_{5Y}, so that a new liquidity gap -569,50 Mio. € originates, whose $PVLiS_{5y}$ is equal to -563,84 Mio. €. The proceeding repeats until the 1Y. The sum of the "new" present values over all time-buckets is the liquidity costs/earnings, dependent on the sign. In the basis case, the earnings are 178,35 Mio. €. The PV of the liquidity costs/earnings therefore corresponds to the amount of money that the bank currently has at current market conditions in order to close its liquidity gaps.

The valuation of the stress scenario is carried out in the same way. The parallel shift is calculated as in the section "Selection and design of the stress test". The widening of the liquidity spreads, based on the historical development from 01/2000-10/2017, is +83/-10 basis points.

Table 3: Calculation of the liquidity assets' total PV of the example bank for the basis case, static analysis[10]

Maturity	*1Y*	*2Y*	*3Y*	*4Y*	*5Y*	*6Y*	*7Y*	*8Y*	*9Y*	*10Y*
NCF_t	-569	-280	-390	-390	-585	390	650	195	260	910
	7,77	7,77	7,77	7,77	7,77	7,77	7,77	7,77	7,77**	910,00*
	1,98	1,98	1,98	1,98	1,98	1,98	1,98	1,98	267,77	
	1,23	1,23	1,23	1,23	1,23	1,23	1,23	204,75		
	3,15	3,15	3,15	3,15	3,15	3,15	660,98			
	1,37	1,37	1,37	1,37	1,37	404,13				
	-1,32	-1,32	-1,32	-1,32	-569,50					
	-0,38	-0,38	-0,38	-375,81						
	0,04	0,04	-376,19							
	0,24	-266,15								
	-554,91									
PV_t	-555,52	-267,21	-377,07	-374,94	-563,84	396,02	639,32	195,14	250,60	835,86
$\sum PV_t$	178,35									

10 Source: own proceedings.
Remark: * "New" NCF_t after closing transactions. ** Costs/earnings caused by the closing transactions.

The difference between the basis and the stress PV shows the change in liquidity assets resulting from the occurrence of the modelled crisis. In case of spread widening by +83BP, the bank loses 32,44 Mio. €. In case of negative widening by -10BP, the difference between the PV_{base} and $PV_{scenario}$ is positive: 3,87 Mio. € and consistent with expectations of gaining more value interrelated to favourable financing conditions. The PV difference shows the risk of potential liquidity costs change due to a distress, as shown in Table 4.

Table 4: Results for the Basis and Stress Scenario[11]

	Δ LS	*Present Value (Mio €)*	*Present Value difference*
Basis Case	–	178,35	
Szenario Max (BP)	83	145,91	-32,44
Szenario Min (BP)	-10	182,22	3,87

11 Source: Own proceedings. Remark: The estimation is only valid if the transactions are not changed over the entire period and the gaps are closed in the form as shown. For a detailed analysis in the relevant time-buckets, the detailed analysis is recommended, as in Schmitt (2016).

Dynamic Scenario Analysis

Here, the focus is on interest rate effects that arise over time. The calculation is carried out on the planning horizon of one year according the section "Static scenario analysis". Table 5.

Runtime reduction: The PV of liquidity assets at the planning horizon is 752,17 Mio. € in the basis case. The calculation is shown in Table 5.

Separate calculation of cost of capital in the 1Y: The gap is valued at the refinancing rate of 1Y. Its PV in the basis case is -569,63 Mio. €. The imputed costs for the liquidity assets of the first year are determined by the difference between the gap amount and the PV of the fictitious closure costs. They are -0,63 Mio. € in the basis case.

The total value over the whole maturity spectrum is the sum of the present values of the first year and the remaining maturity buckets. It is in the basis case 182,54 Mio. €.

Table 5: Calculation of the Total PV of the Liquidity Assets of the Example Bank for the Basis Case, Dynamic Analysis[12]

Maturity	*1Y*	*2Y*	*3Y*	*4Y*	*5Y*	*6Y*	*7Y*	*8Y*	*9Y*
NCF_t	-280	-390	-390	-585	390	650	195	260	910
	20,82	20,82	20,82	20,82	20,82	20,82	20,82	20,82	910,00
	6,60	6,60	6,60	6,60	6,60	6,60	6,60	280,82	
	4,07	4,07	4,07	4,07	4,07	4,07	222,42		
	11,36	11,36	11,36	11,36	11,36	681,49			
	5,68	5,68	5,68	5,68	432,85				
	-4,99	-4,99	-4,99	-536,47					
	-1,77	-1,77	-346,46						
	-0,60	-348,23							
	-238,83								
PV_t	-239,12	-346,72	-340,30	-515,84	405,54	616,13	195,90	233,19	742,39
$\sum PV_t$	752,17								
PV_0	-569,63								
$PV_0+\sum PV_t$	182,54								

12 Source: own proceedings.

As shown in Table 6, if spreads widen by +83BP, the bank loses 15,8 Mio. € compared to the basis case. If spreads widening is negative, e.g., -10BP, the loss is 1,76 Mio. €, which is in line with the time-effect of the interest rate movement.

Table 6: Results for the basis and stress scenario[13]

	ΔLS	*Present Value (Mio €)*	*Present Value difference*
Basis Case	–	182,54	
Szenario Max (BP)	83	166,74	-15,8
Szenario Min (BP)	-10	180,78	-1,76

Interpretation of results

In both approaches, the total PV indicates a “good” liquidity situation of the example bank across the entire planning horizon. Even under the modeled distress stays the PV positive. Nonetheless, in the period up to 5Y, liquidity coverage will be necessary to fulfill the condition of ability to pay all obligations at any time. Earnings are reduced when the liquidity spreads widen; hence, this amount should be compensated with the corresponding CBC.

A direct comparison of the two approaches shows the difference resulting from the observation time point. The PV in the dynamic scenario is approximately 4 Mio. € higher than in the static case, which can be justified by the more favourable financing conditions of longer maturities. The effects are especially visible in the dynamic case: the PV over the shortened maturity spectrum in the basis case is 752,17 Mio. €. Its higher positive amount is explained by removing of the first negative gap. By implication, the total level of the asset is higher. The results are similar for the stress scenarios: because of the rising liquidity spreads, asset values fall and vice versa.

In the current situation, when the market interest rates are at historically low levels and as shown in Table 2, they are equal in the first four time-buckets, the results show similar values. If the underlying interest rate curves will change in the near future, the negative gaps automatically can be closed at higher costs. The present approach also helps to investigate situations when different scenarios of simultaneous changes in interest rates and liquidity spreads are modeled.

13 Source: own proceedings.

Discussion

The present approach is suitable for strategic decisions regarding the structuring of future financing options. The effect of different spread changes on the gap constellation can be investigated quickly and effectively. The bank can adopt targeted strategies in which it makes sense to keep certain gaps open intentionally. Alternative developments can be illustrated in advance and the possible losses can be quantified.[14] A reason therefor could be expectation of more favourable market conditions at a later date, and therefore beneficial closure of the positions. It is possible to calculate how much money would have to be saved or paid under the strategy of waiting. The refinancing strategies can thus be analysed on an ad-hoc basis for different scenarios with a manageable amount of computational effort and on a clearly understandable basis. A scale of risk-coverage capacity for the whole period can also be recommended.

In particular, the dynamic-model approach, which focuses on the planning horizon, is suitable for planning financing options for longer periods. Strategic decisions with regard to balance sheet changes, new financing options, and measures in the event of changes in yield curves are supported. The PV calculation method offers a quick, clear, and easy possibility to interpret procedure. The effects of the changes in the liquidity structure are visible in isolation, even when viewed dynamically over the whole planning horizon. The results also help to plan the determination of a realistic size for setting the appropriate CBC-amount per time-bucket. The planning of the necessary preparations for extreme cases can be carried out. When interpreting the results of the dynamized stress test, two effects that can occur must receive attention:

If the LGR shows negative gaps, the steepness of the liquidity spread curve leads to a reduction in financing costs (for the raising of liquidity) by a reduction of the remaining term to maturity,

[14] An allocation of scenario-occurrence probabilities is not aimed in the present study. It serves as a first and strategic step to identify potential of shortcomings, which in second step can be treated in a detailed analysis, if needed. Confer Schmitt (2016) and Schmitt (2015) for Value at Risk based approach and time-point view.

If the gaps in the LGR are positive, the income from the investment of excess liquidity is reduced due to the shortened residual maturities.

The calculation of the PV of liquidity costs makes the value-oriented valuation of liquidity gaps and its integration into the value-oriented overall bank management possible.

However, there is a tendency to overestimate the cost side. This effect occurs because the closing transactions of the negative gaps bear interest at a higher refinancing rate, while the positive gaps bear interest at a lower market rate. Following, the calculated liquidity need is increased due to the notional financing costs resulting from the closing of the LGR. At the same time, it should be acknowledged in line with the principle of prudence.

Conclusions

The focus of the present stress-test approach is on measuring the effect of the change in the liquidity spread on total liquidity assets over the entire maturity spectrum of LGR. The basis for the risk calculation is the present value-oriented analysis of LMT risk. The approach meets the regulatory requirement for the implementation of market-wide and institution-specific scenarios. As this approach allows a view of different refinancing strategies with manageable effort, it is also possible to detect liquidity constraints at an early stage. The liquidity market price risk is included by changing the liquidity spread due to negative market developments, taking into account the risks from open liquidity positions in the LGR.

Acknowledgement

I thank Prof. Bernd Rudolph for useful suggestions, Andreas Schmitt for technical support, Dr. Christian Sievi, and Thomas Graf for helpful comments.

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