INSTITUT DE FINANCEMENT DU DÉVELOPPEMENT DU MAGHREB ARABE

End of Studies Project

Topic :

Liquidity Risk Management using the ALM Approach

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Dedication

In recognition of your unwavering support and belief in me, I dedicate this work to you, my cherished family : mom, dad, sister and friends. Your love and encouragement have been the driving force behind my accomplishments.

You have nurtured my dreams and cheered me on every step of the way, this work is a testament to your unwavering love and encouragement. I am forever indebted to your presence in my life.

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Abstract

Banking risks have become a focal point of attention in the financial system, and the current scenario calls for more effective and efficient risk management strategies to ensure the sustainability and optimize the profitability of banking institutions. In this context, the ALM approach has emerged as a comprehensive method to effectively manage interest rate risk, foreign exchange risk, and particularly liquidity risk, which is the primary focus of this paper.

This research endeavor aims to implement liquidity risk management practices using the ALM approach within QNB. To achieve this objective, a variety of methods will be employed, including the Auto Regressive Distributed Lag (ARDL) model and liquidity gap analysis.

Keywords: banking institutions, the ALM approach, liquidity risk, ARDL model, liquidity gap.

Résumé

Les risques bancaires sont devenus un point d'attention central dans le système financier, et le scénario actuel exige des stratégies de gestion des risques plus efficaces et plus efficientes pour assurer la durabilité et optimiser la rentabilité des institutions bancaires. Dans ce contexte, l'approche ALM est apparue comme une méthode complète pour gérer efficacement le risque de taux d'intérêt, le risque de change et, en particulier, le risque de liquidité, qui est le principal axe de cet article.

Ce travail de recherche vise à mettre en œuvre des pratiques de gestion du risque de liquidité en utilisant l'approche ALM au sein de la QNB. Pour atteindre cet objectif, diverses méthodes seront employées, notamment le modèle Auto Regressive Distributed Lag (ARDL) et l'analyse des impasses de liquidité.

Mots clés : institutions bancaires, l'approche ALM, risque de liquidité, modèle ARDL, impasses de liquidité.

Contents

List of Abbreviations

ADF : Augmented Dickey Fuller

ALCO : Asset-Libility Committee

ALM : Asset-Liability Management

ARDL : Auto Regressive Distributed Lag

BCT : Central Bank of Tunisia

BIS : Bank For International Settlements

CEO : Chief Executive Officer

DD : Demand Deposits

FCC : Common Debt Fund (Fonds Commun de Créances)

GIC : Guaranteed Interest Contract

HQLA : High Quality Liquid Assets

IRR: Interest Rate Risk

LCR : Liquidity Coverage Ratio

LTD : Loan To Deposit

NBI : Net Banking Income

NSFR : Net Stable Funding Ratio

HQLA : High Quality Liquid Assets

ROA : Return On Assets

ROE : Return On Equity

RSA : Rate Sensitive Assets

RSL : Rate Sensitive Liabilities

QNB : Qatar National Bank

SD : Savings Deposits

SME : Small and Medium-sized Enterprise

SSA : Special Savings Account

SICAR : Capital Risk Investment Company (Société d'investissement en capital à risque)

T-bills : Fungible treasury bills (Bons de Trésors Assimilables - BTA)

TQB : Tunisian Qatari Bank

VSE : Very Small Entity

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General Introduction

In contemporary times, economic growth stands as a paramount concern for governmental authorities worldwide. This growth is heavily reliant on banking institutions, playing a pivotal role in financing through their financial intermediation activities between entities with financial capacity and those in need of funding.

This intermediary activity is manifested through operations that transform maturities and amounts, granting long-term loans by collecting short-term resources with different remuneration rates. Consequently, this mismatch in maturities and rates exposes banks to numerous financial risks, including liquidity risk, necessitating the implementation of a suitable policy for the identification, quantification, and control of these risks.

In fact, Basel regulations traditionally focused on the solvency risk of banks until the occurance of the "Subprime" crisis, which marked a pivotal shift in risk management. The international financial crisis of 2007, propagated globally through contagion mechanisms, not only revealed shortcomings in banks' liquidity management but also emphasized the fundamental role of liquidity in ensuring the proper functioning of financial markets and the banking sector. This crisis highlighted the rapid depletion of liquidity and the persistent nature of deficits, leading central banks to intervene to restore financial stability. In response, Regulators recognized the importance of liquidity risk, leading to the introduction of new prudential standards to ensure a more rigorous risk management policy.

The Basel Committee on Banking Supervision, hence, incorporated liquidity risk alongside credit, market, and operational risks, issuing both quantitative and qualitative standards to regulate this risk. Regulatory measures were imposed to permanently strengthen the stability and resilience of banking institutions.

In addition to compliance with prudential standards, banks are required to create their risk management tools. Continuous monitoring of market developments and information to understand the current and future situation of the various markets in which the bank operates is essential for effective liquidity and risk management.

In this context, the Asset Liability Management (ALM) approach emerged as an effective method for managing a variety of financial risks, including liquidity, interest rate, and exchange rate risks. This approach enables managers to make informed decisions based on various indicators to ensure better alignment between the bank's assets and liabilities.

In fact, similarly to the BCT, the Central Bank of Algeria supervises this management approach by regulatory texts. The primary aim is to enhance the supervision of risks impacting the liquidity and solvency of banks and financial institutions. Specifically, the objective is to prevent severe liquidity crises, a crucial variable with far-reaching implications for the entire banking system.

However, despite earnest efforts undertaken by the Algerian banking sector in terms of regulatory frameworks, especially those pertaining to the control and management of liquidity risk in credit institutions, asset-liability management is not yet standardized. It remains timid in its application and is not widely adopted across Algerian banks. This disparity prompted an exploration of the Tunisian experience with ALM, where the approach is notably more standardized. Consequently, the objective is to elucidate the liquidity risk management process, emphasizing its significance and utility.

In reality, banks in Tunisia are exposed to multiple banking risks, especially in light of today's economic environment, which is marked by a number of challenges hampering the country's recovery from a lost decade of growth post-2011 and the disruptive impact of the pandemic. This struggle is particularly concerning in the face of liquidity scarcity, posing a serious threat to the banking sector. The compounded effect of economic challenges and liquidity shortages emphasizes the urgency and significance of effective liquidity risk management practices in the Tunisian banking system. Thus, the focus of this thesis is encapsulated in the following question:

« **How does the ALM approach contribute to the liquidity risk management in a Tunisian bank ?** »

A question that we will try to apply in the case of Qatar National Bank, providing an opportunity to contextualize the insights gained from the Tunisian experience.

This question can be further dissected into a number of sub-questions:

- What is bank liquidity?
- What is liquidity risk?
- What does asset-liability management consist of?
- What are the measurement tools proposed by ALM for managing this risk?
- To what extent is QNB exposed to liquidity risk?

In order to provide answers to these questions and address the main issue, we have organized the work into three chapters:

The first chapter sheds light on the general background of liquidity, liquidity risk, as well as the prudential supervision and regulation framework.

As for the second chapter, it outlines the conceptual framework of the ALM approach, and its contribution to liquidity risk management as a tool, delving deeper into its process and techniques.

In the concluding chapter, we will present the hosting institution and its current situation. We will perform a general diagnosis of the bank's assets and liabilities, along with a statistical analysis of the non-contractual components in the balance sheet (overdrafts, demand deposits, and savings). Then, by forecasting these elements, we will quantify the bank's exposure to liquidity risk through the establishment of maturity profiles and liquidity gaps.

CHAPTER ONE :
THEORETICAL FRAMEWORK & LITERATURE REVIEW

Introduction

The optimal performance of any economy and any banking system depends essentially on the financial health of banks and financial institutions, which is closely linked to the degree of control of the risks inherent in their activities. In fact, in the context of their operations, banks face various risks that must be identified and managed in order to minimize, or even avoid, the potential losses they could cause.

Liquidity and liquidity risk-taking represent two extremely important notions in the business world and particularly in banks. As part of their activities, the latter are regularly confronted with many risks that can affect their profitability and hinder their performance.

Liquidity risk comes from the transformation activity of the bank, and its management does not necessarily require a reduction in this transformation, but to assess at what price and in how long the bank will be able to honor its commitments. But first, it is important to understand what liquidity is and to define liquidity risk in depth.

Following the financial crises, the supervisory authorities have reinforced all prudential regulations. Compliance with these rules guarantees rigorous monitoring of the institutions' financial situation.

The objective of this first chapter is to provide an overview of bank liquidity within the financial institutions, to analyze its crucial importance as well as the factors that influence liquidity risk. And finally, to explore the various prudential regulations related to this risk, established internationally and at the national level within the banking system in Tunisia.

In order to effectively address these points, we found it beneficial to split this chapter into three (03) sections:

- General background on liquidity ;
- Overview of Liquidity risk ;
- Prudential supervision and regulation.

1 General background on Liquidity

The term "liquidity" is anything but well defined. In any relevant discussion with colleagues in the treasury department of other banks or with liquidity controllers, one can be sure that everyone has a solid understanding of liquidity and risk as terms. However, it often happens that one reaches an advanced stage of the discussion before arriving at a common understanding of the specific elements of liquidity that are discussed. This is somewhat surprising considering that this issue has been around for a very long time (Duttweiler, 2009). So what exactly is liquidity?

1.1 Definition

Liquidity, which we broadly define as the availability of cash or equivalent resources, is the lifeblood of any business entity. Liquidity allows for planned and unforeseen obligations to be met when needed, so that day-to-day business can run without disruption. In the absence of sufficient financial resources, activities may be jeopardized; more importantly, the likelihood of encountering more serious financial difficulties increases. Liquidity is therefore a vital part of financial management and needs to be carefully considered and managed (Banks, 2014).

The notion of liquidity in the economic literature refers to the ability of an economic agent to exchange its existing wealth for goods and services or other assets (Nikolaou, 2009). Liquidity pertains to the immediate accessibility of cash and cash-equivalent liquid assets retained by the bank, serving the purpose of fulfilling payment commitments and supporting asset funding. (Ghosh, 2012).

For a bank, liquidity is considered as the capacity to finance the assets of the bank and to reimburse the commitments made (the liabilities) when these fundings or these reimbursements arise. In other words, liquidity translates into the capacity of the bank to fulfill its commitments. The ability of the bank to honor its obligations in cash according to their maturity. It can then be measured by the quantity of money held by the banks with the central bank, materialized by banknotes and the credit balance of their current accounts with the central bank.

Liquidity is also known as a bank's capacity to source the essential funds required to fulfill its commitments, at a reasonable price and at all times. Liquidity risk therefore consists of not being able to meet immediate liabilities with available liquidity (Darmon, 1998).

Liquidity is therefore neither an amount nor a ratio. Rather, it represents the extent to which a bank is able to fulfill its respective obligations. The opposite of liquidity would be "illiquidity", ie the lack of capacity required to fill them. In this sense, liquidity represents a qualitative element of a bank's financial soundness (Duttweiler, 2009).

1.2 Sources of liquidity

Bank liquidity can come from several sources that can be summarized in two main categories:

1.2.1 Liquid or semi-liquid assets

- **Cash** : Primary source of liquidity for the bank, very liquid in nature.
- **Semi-matured assets** : Assets held by the bank whose maturity is nearing its term, it is:

- From the portfolio of loans, which provides the bank by their recovery of the liquidity.
- Securities and money market instruments: Treasury bills, loans interbank.

- **Easily liquidable assets** : Assets held by the bank, which can provide liquidity through sales or cash collateral, we mainly find:

- Securities that can be easily sold on the market without significant loss in capital;
- Securities eligible for central bank refunding operations (open market, liquidity injection) generally consisting of public securities, corporate bonds and private debts, the conditions of acceptance are restricted to those who present more guarantee;
- Customer loans which, depending on the country and the type of loan, can be more or less easily sold either directly on a market or through structured transactions such as securitization.

1.2.2 The ability of the institution to attract new savings

- The ability of business units to attract new savings in the form of deposits is a very advantageous source of liquidity,
- Another source of liquidity is the facility available to a bank to access capital markets. This depends on the notoriety of the bank, the level of equity funds, its size, the quality of its shareholding (quality of its signature) as well as market conditions.

1.3 Liquidity functions

Liquidity is essential for a bank, given all the functions it performs (Bailly, 2006):

1.3.1 Guaranteeing the ability to grant loans following commitments

The bank must maintain a certain level of liquidity in order to respond to the following operations: withdrawals of funds, unexpected loan requests, in particular within the framework of firm lines of credit granted to its customers.

1.3.2 Avoiding forced sales of assets

The bank may be forced to sell its assets to restore its liquidity when it cannot renew its borrowings when due.

1.3.3 Repaying debts

Allows the bank to guarantee itself the ability to repay its debts without being obliged to renew them.

1.3.4 Avoiding Central Bank Dependence

Each bank tends to turn to the central bank to borrow and generate additional earnings (discount rate lower than the borrowing rate on the interbank market). However, the bank must comply with the conditions set by the central bank in the event of an illiquidity situation.

1.3.5 Reassuring creditors

One of the main purposes of liquidity is to dispel creditor concerns. They are more concerned with the risk of not getting their funds back than with the compensation.

1.3.6 Avoiding high interest payments

Liquidity allows the bank to avoid appearing as a borrower on the market, which prevents it from paying high interest rates (usurious rates).

1.4 Types of liquidity

Bank liquidity can be classified into three categories:

1.4.1 Central liquidity

Central bank liquidity is synonymous with the central bank's capacity to supply essential liquidity to the financial system. Typically, it is quantified by assessing the liquidity infusion into the economy originating from the central bank, which entails the flow of the monetary base from the central bank to the financial system. (Nikolaou, 2009). It is a safe source for tier 2 banks, as the central bank is the lender of last resort. Access to this source is regulated by the regulatory authorities according to the objectives of the country's monetary policy and situations of excess or deficit of global liquidity.

1.4.2 Market liquidity

The notion of market liquidity has existed since at least Keynes in 1930. Nonetheless, it has taken a substantial period for a widely accepted definition to develop. Numerous contemporary studies characterize market liquidity as the capability to trade an asset efficiently, resulting in minimal influence on its price, reduced transaction expenses, and the swiftness in executing trades (Nikolaou, 2009). This form of liquidity corresponds to the liquidity that a bank can maintain through the sale of its liquid assets. It pertains to the liquidity of marketable assets, This includes assets like monetary instruments or assets that can be readily converted into cash without experiencing a substantial decrease in value.

Nevertheless, the availability of this source of liquidity is contingent upon the liquidity of the secondary market where these liquid assets are traded.

1.4.3 Funding liquidity

Funding liquidity, as defined by the Basel Committee on Banking Supervision, corresponds to the ability of banks to meet their commitments, liquidate or settle their positions when due (BIS, 2008). It represents a cash flow situation where banks are able to meet their obligations on time. It is therefore an internal source that combines liquid and semi-liquid assets, as well as the borrowing capacity of a bank, etc.

However, it should be noted that there is an interaction between these types of liquidity. This relationship has its origin in the relationship between depositors, the banking system and operators in the financial markets, which can sometimes influence the liquidity of banks.

2 Overview of liquidity risk

Liquidity is defined by its constant availability rather than being available only on average or most of the time. To maintain liquidity, payments must be made promptly on their due date. Failure to comply with these obligations can lead to the bank being considered illiquid (Duttweiler, 2009).

2.1 Definition

When liquidity signifies the presence of cash or easily convertible assets, liquidity risk can be characterized as the risk of incurring losses due to an absence of cash or readily convertible assets. To be more precise, it's the risk of encountering losses stemming from the incapacity to secure funding at economically viable terms to meet an anticipated or unforeseen

obligation. Liquidity risk can therefore be viewed as the risk of economic loss incurred in finding the cash so vital to business activities (Banks, 2014).

It represents the danger of not being able to meet payment obligations, where non-compliance leads to undesirable consequences. Hence, liquidity risk is essentially the risk that a bank may be unable to renew or replace its assets when its liabilities mature, regardless of the underlying cause (Choudhry, 2011).

2.2 Types

There are two main types of liquidity risk:

2.2.1 Funding liquidity risk

In this scenario, an institution is unable to meet its obligations as they come due because it is unable to liquidate assets or obtain adequate funding (Vintzel, 2010). Funding liquidity concentrates on the accessibility of unsecured liabilities that can be converted into cash, encompassing both short-term and long-term debt arrangements. Consequently, funding liquidity risk encompasses the risk of suffering losses due to the incapacity to tap into unsecured funding sources at a cost that makes economic sense to fulfill obligations. In simpler language, funding liquidity risk signifies the worry that a company might be incapable of settling its liabilities when they become due (Nampoothiri, 2015).

2.2.2 Market liquidity risk

In this context, some assets cannot be sold without significantly reducing market prices due to limited market depth or disruptions (Vintzel, 2010). Market liquidity is related to both assets and liabilities. Adverse market conditions may impede the ability to convert marketable assets into cash or obtain necessary funding. It is also possible to experience a combination of both effects. In essence, market liquidity risk pertains to the apprehension that specific assets may be challenging to sell because of an overall scarcity of liquidity in the market., thus preventing the generation of cash for the business.

2.3 Sources of liquidity risk

Darmon (1998), sees that the liquidity risk's origin is based on 3 essential factors presented as follows:

2.3.1 The transformation function

The liquidity risk inherent in banks stems from their role in carrying out permanent transformations in maturity, which are impacted by market volatility and the active

management of their balance sheets by banks. Previously, banks mainly relied on passive collection of deposits, with the acquisition of assets being the main objective of their activities. The main liquidity risk was related to the possibility of deposit withdrawals. However, with changing markets and many opportunities to find profitable assets, banks are now using sources of funding other than customer deposits, such as the interbank and bond markets, to optimize their profitability.

2.3.2 The confidence of economic agents

The confidence generated by an institution allows it to carry out its operations, refinance itself under the best conditions and thus generate profitability that further improves its image on the markets. On the other hand, as soon as this confidence is eroded, the cost of resources automatically increases, access to new markets is limited and the resulting deterioration in results, real or anticipated, further aggravates the damage caused to confidence in the bank. Similarly, a lack of liquidity leading to a reduction in the volume of transactions would lead to a decrease in results and concern about the future of the institution. This loss of confidence can have several origins, in particular: market rumours, changes of directors, the materialization of a significant market risk, or even the default of a counterparty.

2.3.3 The institutional context in which the bank operates

Liquidity crises can arise not only due to specific difficulties encountered by a bank, but also as a result of a general liquidity crisis in the market. This global lack of liquidity can result from the interaction between supply and demand on the markets, from the voluntary intervention of the monetary authorities on global liquidity or from the evolution of the regulatory system deterring investors from intervening in a particular segment of the market (Darmon, 1998).

2.4 Liquidity risk factors

After having definined liquidity risk and determined its main types, it is essential to identify its sources which are grouped into two main categories:

2.4.1 Endogenous factors

They are a number of six :

2.4.1.1 The transformation of deadlines

The transformation function of banks can lead to liquidity risk. The contrast in timeframes between assets and liabilities implies that cash inflows may not always cover cash

outflows. A bank that transforms a short-term resource into a longer-term commitment is significantly exposed to liquidity risk (because it is supposed to be more profitable).

2.4.1.2 The attitude of economic agents

According to (Darmon, 1998), trust plays an essential role in allowing a financial institution to refinance itself and conduct its operations under optimal conditions, thus generating profitability that strengthens its reputation on the market.

On the other hand, when confidence is low, the costs of resources increase, access to new markets is limited, and this translates into a deterioration of the results (insufficient liquidity leads to a reduction in the volume of transactions and, result in lower results), raising fears about the future of the institution.

2.4.1.3 The concentration of loans and deposits

It is necessary to diversify the credits and the customers to whom they are granted.

Banks need to diversify their sources of funding (large depositors and small depositors) because if the bank has only one funding source (for example large depositors only) and if one or more of them withdraw their money, the financial institution risks not finding other sources to replace these large outgoing depositors.

2.4.1.4 Off-balance sheet flows

Transactions kept off the company's balance sheet do not involve an immediate mobilization of funds. In other words, they are commitments by signature that can turn into immediate liquidity needs if necessary.

2.4.1.5 The insolvency of the borrower

Results in a partial or even total loss of the claim, as well as the associated income, leading to a lack of the initially anticipated liquidity.

2.4.1.6 Trading risk

Occurs when assets cannot be easily liquidated. This can be the result of:

- Deterioration in the quality of securities held by the bank;
- Global crisis in the securities market.

2.4.2 Exogenous factors

They are a number of two :

2.4.2.1 Systemic crisis

The bank may suffer a liquidity risk following a systemic crisis, which is an exogenous factor to the latter, it is experienced when there is a contraction of liquidity in the market following troubles affecting the system in a heavy way, financial and monetary. The factors that triggered this crisis have been very well explained by (Durbernet, 1997).

2.4.2.2 The institutional context in which the establishment evolves

Insufficient general liquidity may be the result of market supply and demand, the voluntary intervention of monetary authorities and changes in the regulatory framework that manages bank liquidity. Something that can turn into a general liquidity crisis.

3 Prudential supervision and regulation

Prudential regulation has undergone a strong evolution in recent years under the impetus of the work of the Basel Comity. In fact, the nature of the banking activity and the competitive landscape in which the bank operates expose the latter to a multitude of financial risks threatening its continuity of operation and endangering the entire financial system. To this end, the monetary authorities have today proceeded to put in place prudential rules with the aim of guaranteeing proper supervision of banks, Ensuring the safety of depositors and maintaining a stable financial system.

However, this prudential regulation imposes on banking establishments the permanent observance of certain ratios such as that of liquidity, solvency, risk concentration, etc., through the implementation of prudential risk management and control systems, thus enabling them to strengthen their financial solidity and to protect them against failure.

3.1 International regulations relating to liquidity risk

It should be underlined that at the level of the recommendations drawn up at the level of both Basel I (1988) and Basel II (2004) accords, the liquidity risk was not developed enough and these agreements did not implement international standards relating to this risk. However, the report whose title is "Principles For Sound Liquidity Risk Management And Supervision" published for consultation by the Basel banking supervision committee, Emphasized the significance of liquidity and the associated risk while formulating several recommendations and encouraging credit institutions to equip themselves with sound and rigorous ifs to identify, quantify, monitor and control liquidity risk.

The recent "Subprime" crisis and its consequences on all financial systems around the world revealed the importance of liquidity and the failure of the systems put in place by banks to manage liquidity risk. In response to this crisis, the Basel III agreements produced new international regulations relating to the monitoring of liquidity and they integrated the related risk alongside that of credit, market and operational. This regulation is intended, on the one hand, to further strengthen the solvency of banking establishments by improving the quality and level of capital and, on the other hand, to limit the occurrence of a new liquidity crisis by the establishment of two new liquidity ratios, the first of which corresponds to a short term ratio (LCR) and the second has a longer term structural liquidity ratio (NSFR).

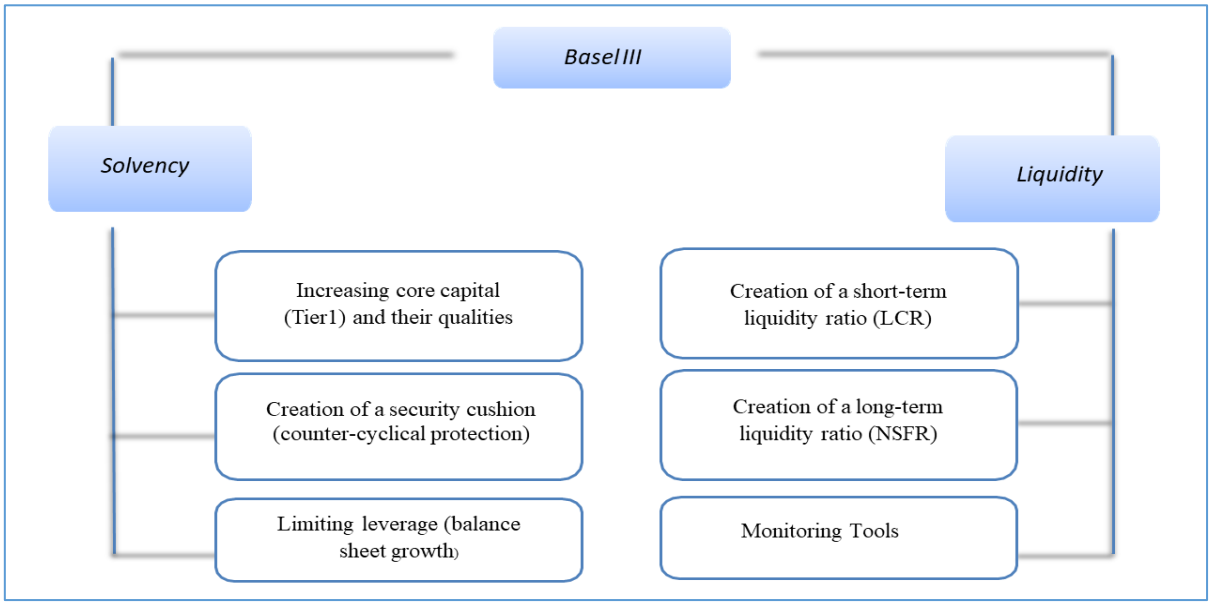


Figure 1: The new contributions and measures of Basel III **Author's work, inspired from BIS.com**

3.1.1 The Liquidity Coverage Ratio

Having come into effect on October 1st, 2015, The liquidity ratio over the short term aims to fortify the bank's ability to withstand a short-term liquidity crisis. In fact, according to this standard, the bank must hold an appropriate pool of high-quality liquid assets (HQLA) that can be readily converted into cash on the market without incurring a significant loss, thus enabling it to meet its liquidity needs for the next 30 calendar days, following the occurrence of an adverse event such as a massive withdrawal of money.

This short-term liquidity ratio is defined as the ratio between outstanding high-quality liquid assets and total net cash outflows over 30 calendar days.

$$\boldsymbol{LCR = \frac{\text{High quality Liquid Assets}}{\text{Total Net Cash Outflows (30 days)}} \geq 100\%}$$

- **High-quality liquid assets**: these assets retain the character of liquidity even in times of crisis and can be accepted in most cases for transactions with the central bank. Among these assets we find by way of example (treasury bills, securities issued by a public body, financial institutions, insurance companies, liquidity with the central bank, etc.).
- **Net cash outflows**: correspond to all of the cash outflows of the following month minus the total inflows of liquidity for the same period under the condition that the latter must not exceed 75% of the forecast cash outflows and this to ensure the existence of a minimum stock of high-quality liquid assets.

From its entry into effect, the minimum level of the liquidity ratio was 60% and it has gradually increased each year by 10% to reach a minimum requirement of 100% in 2019. However, banks are required to comply with this ratio at all times.

Table 1: Evolution of minimum liquidity ratio requirements (LCR)

	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019
LCR minimum requirements	60%	70%	80%	90%	100%

Taken from : BCT circular 2014-14

3.1.2 The Net Stable Funding Ratio

The long-term structural liquidity ratio also known as the Net Stable Funding Ratio was introduced by the Basel III accords for banking supervision with the aim of fortifying the bank's resilience in the face of prolonged liquidity stress scenarios.

This long-term liquidity norm supplements the short-term obligation (LCR) and aims to ensure that credit institutions are able to hold a sufficient stock of stable financial resources based on the liquidity characteristics of their assets and potential funding requirements stemming from off-balance sheet commitments and obligations within a one-year timeframe. In addition, through this ratio, the banks will be required to finance their stable assets with resources (liabilities) of more or less longer maturities, which is likely to limit their maturities transformation activity and reduce the resulting risks.

The calculation of this long-term liquidity ratio, which must be greater than or equal to 100%, consists of dividing the bank's outstanding stable resources (Available Stable Funding) by the amount of required stable funding (Required Stable Funding).

$$NSFR = \frac{\text{Available amount of stable funding}}{\text{Required amount of stable funding}} \geq 100\%$$

- **The amount of available stable funding (resources)**: Equals the total of the liabilities' book values listed on the balance sheet and the bank's equity, weighted by their own coefficients (established by the Basel comity) according to their liabilities. It should be mentioned that when the exigibility of a liability item increases its stability decreases.
- **The amount of required stable funding**: corresponds the total of the book values of balance sheet and off-balance sheet assets, also weighted by their own coefficients. These vary inversely to the degree of liquidity of the asset. In other words, When the liquidity level of an asset or an off-balance sheet item rises, its stability and weighting coefficient decrease.

Aside from the short-term liquidity ratio (LCR) and the long-term liquidity ratio (NSFR), the Basel III committee also recommended that banking establishments implement liquidity risk monitoring tools, with the objective of ensuring a certain consistency in terms of management and monitoring of this risk at the international level.

3.2 National regulations relating to liquidity risk

They come down to :

3.2.1 The Liquidity Coverage Ratio

According to the circular of the Central Bank of Tunisia No. 2014-14 of November 10, 2014 relating to the liquidity ratio, all banks are required to permanently respect a short-term liquidity ratio (LCR) whose minimum requirement is 60% from January 1st, 2015 and which gradually increases each year by 10% to reach a level of 100% in January 1st, 2019.

The calculation of this liquidity norm involves the ratio between the amount of high-quality liquid assets and that of the net cash outflows during the following 30 calendar days (provided that the forecast cash inflows must not exceed 75 % of the total anticipated cash outflows).

$$LCR = \frac{\textbf{High quality Liquid Assets}}{\textbf{Expected cash outflows (30days)} - \textbf{Expected cash inflows (30 days)}}$$

With regard to liquid assets, just like international regulations, there are two categories, level 1 assets and level 2 assets classified according to their degree of liquidity. Moreover, when calculating the liquidity ratio by the bank, these assets must be unencumbered[1].

[1] The word encumbered means that the asset cannot be easily liquidated, transferred or affected due to legal, regulatory, judicial, contractual or other restrictions.

It should be underlined that all banks are obliged to submit each month to the Central Bank of Tunisia the situation of their short-term liquidity ratios within a period not exceeding the first 10 days of the month concerned. However, if a bank does not comply during 3 successive months with the minimum requirement of the LCR, it will be obliged to submit to the BCT an action plan which includes all the emergency measures to be put in place in order to overcome its situation regarding non-compliance with the regulations in force and this within a period which does not exceed 10 days from the statement of its liquidity ratio relating to the 3rd month (Circular n°2014-14 of 10 November 2014 relating to the liquidity ratio, article 14).

3.2.2 The Net Stable Funding Ratio

At the national level, this regulatory ratio is not yet applied in Tunisia. However, in the face of persistent tensions on liquidity in the banking sector, prompting the Issuing Institute to provide an increasing refunding effort, BCT circular 2018-10 of November 1st, 2018 also saw the introduction of a new ratio called the "Loans/Deposits Ratio" which aims to establish more effective management of transformation risk and to prepare banks for the application of the Basel III NSFR long-term liquidity ratio.

3.2.3 Introduction of the LTD ratio by the BCT

Watching over financial stability and drawing inspiration from the experience of other countries which aim to limit the risk of transformation and protect banks against excessive risk-taking, the Central Bank of Tunisia has established under the circular to banks n° 2018-10 of November 1st, 2018 a new macro-prudential ratio "credit/deposit ratio". The said circular implies that a bank cannot keep this ratio at a level higher than 120%.

The establishment of this ratio is essentially justified by the observation of the accentuation of the risk of maturity transformation following the observation of the excessive recourse of banks to very short-term resources from the BCT. In fact, this risk took on worrying dimensions during 2018 to the point of impacting the financial balances of banks taken individually and the stability of the banking system as a whole.

According to the banking supervision report published by the BCT, the implementation of this ratio does not aim to reduce credit to the economy. The objective is to encourage banks to make more effort and to be more innovative in terms of mobilizing less volatile and less costly customer deposits while leading them to establish more effective management of their transformation risk through dynamic asset-liability management (ALM).

To prevent any disruption in the banks' ability to support economic funding and to lessen the adverse effects on the stability of the banking industry, the monetary authority has adopted a gradual approach to the introduction of this new ratio.

As such, the banks whose "Loans/Deposits" ratio is above 120% at the end of a given trimester must take the necessary measures to gradually reduce their ratio, as at the end of the following trimester, under the following conditions:

Table 2: Limits of the "Loans/Deposits" ratio

Trimester Ratio	Reduction to be applied
"Credits/Deposits" ≥ 122%	Gradual reduction of the ratio by 2% per trimester
120% < "Credits/Deposits" < 122%	Percentage needed to bring next trimester's ratio to 120%

Taken from : BCT circular n°2018-10

In accordance with article 4 of the said circular, in the event of non-compliance with the quarterly drop in the "Credits/Deposits" ratio of 2%, an action plan must be presented to the BCT no later than 10 days after the declaration relating to this trimester including the measures to be taken in order to rectify the situation of the bank in relation to the regulatory ratio. Otherwise, a penalty will be imposed.

However, given the exceptional situation due to the Covid-19 health crisis, the BCT continued to work to preserve the soundness and financial stability of banks by implementing a set of measures which were also accompanied by relaxations of prudential norms, notably the "loans/deposits" ratio. Indeed, banks whose "Loans / Deposits" ratio is greater than 120% at the end of a given quarter must reduce the level of this ratio by 1% instead of 2% each quarter (Circular of the BCT 2020-06)

As a reminder, the Loans/Deposits ratio will be adopted for a limited period of time and will subsequently be replaced by a Basel long-term liquidity ratio. In other words, the LTD ratio is but a preparer ratio for the NSFR.

Conclusion

The stability and sustainability of the banking system closely depend on the effective management of the multiple risks associated with banking activity, which can impact the performance of institutions and the entire financial sector. Thus, compliance with prudential and regulatory standards is of paramount importance to safeguard the robustness and consistency of the banking system.

Banking regulations, overseen by the Basel Committee and national supervisory authorities, seek to cover risks related to liquidity, exchange rates, counterparties and markets.

Liquidity has become a major topic of study in the financial literature, presenting various perspectives on its impact on banks. This plays an essential role in the stability of financial institutions, being the dynamic engine of all banking operations. By ensuring adequate daily cash management, banks can honor their commitments and prevent any potential risk affecting their liquidity.

Faced with increasing regulatory constraints and the complexity of risks, banks are proactively trying to manage their risks and the elements of their balance sheets. To do this, they have adopted an innovative approach called Asset-Liability Management (ALM). This method promotes better adaptation to the challenges of the sector and ensures balanced management of assets and liabilities for optimal financial stability.

CHAPTER TWO :
ASSET & LIABILITY MANAGEMENT METHODOLOGY

Introduction

In recent years, risk management has become one of the major concerns of banking institutions. In response to this need, new management models and techniques have emerged and been implemented.

The ALM intellectual approach, which is constantly evolving, has established itself as an essential conceptual framework for the financial management of banks, thus making it possible to respond effectively to the challenges associated with risk and strategic management.

This method was introduced in the United States in the 1970s and focused on financial risks, more specifically currency risk and liquidity risk. The latter has become one of the major concerns of the banking sector, especially after the subprime crisis in 2007, thus marking a significant development on an international scale.

The objective of this chapter is to introduce this discipline by exploring its evolution and its practical application as a tool for managing liquidity risk, in order to ultimately lead to the rigorous monitoring and control of this risk.

The chapter is therefore divided into three (03) sections :

- Overview of ALM ;
- ALM process and techniques ;
- Liquidity risk management using ALM

In recent years, strategies referred to as Asset Liability Management (ALM) have emerged as a fundamental component of risk management within the banking sector. ALM includes a set of tools aimed at creating value and controlling risk. As the banking world shifts from a primary concern for balance sheet expansion to one for rates of return on capital and risk control, knowledge of ALM becomes a necessity for all bankers responsible for the results of a profit center (Dermine and Bissada, 2002).

1 Overview of ALM

The concept of Asset Liability Management varies from one perspective to another.

1.2 Definition

Asset-Liability Management (ALM) is a crucial risk management technique in the financial sector, aiming to maintain a surplus of assets over liabilities while generating returns. ALM involves strategic fund flow planning, acquisition, and management within financial institutions, ensuring consistent income, liquidity, and gradual capital reserve enhancement, all while managing business risks effectively (Ronil, 2014).

ALM's interpretation varies among market participants. For banks, it signifies high-level asset and liability management, often overseen by the Asset-Liability Committee (ALCO) or the Treasury division. ALM offices manage interest rate and liquidity risks, establishing principles for credit risk management (Choudhry, 2011).

ALM minimizes risk exposure while optimizing asset-liability mixes to meet financial institution goals (Kosmidou & Zopounidis, 2009). It focuses on managing interest rate risk and liquidity, especially in commercial banking activities (Bessis, 2002).

In essence, ALM is an ongoing process involving strategic financial strategies tailored to manage a company's assets and liabilities, aiming to achieve specific financial goals while adhering to predefined risk levels and constraints. This structured approach is essential due to complex banking regulations and the use of intricate models.

1.3 Brief history of ALM

Before the 1970s, developed countries experienced relatively stable interest rates, which mitigated losses resulting from asset-liability mismatches. Funds from liabilities, such as deposits, were invested in assets like loans, bonds, or real estate. During this period, assets and

liabilities were recorded at their book value, concealing potential financial risks in case of sudden mismatches.

However, the 1970s brought significant interest rate instability, extending into the early 1980s, posing substantial risks for financial institutions. An illustrative case is Equitable, which had marketed long-term guaranteed interest contracts (GICs) with high interest rates but invested in short-term rates. When short-term rates dropped, Equitable struggled to honor its GIC commitments, eventually leading to its acquisition by the Axa group.

This experience prompted financial institutions to improve their asset-liability management (ALM) practices. They focused on aligning loans and deposits with long-term growth objectives and risk management priorities. This led to the development of innovative financial methodologies, including gap analysis, duration analysis, and scenario analysis (Habart et al., 2015).

Since the early 1980s, ALM practices and methodologies have advanced significantly. Presently, they oversee accrual-based accounting for assets and liabilities in financial institutions, impacting functions such as lending, deposit mobilization, and insurance operations.

ALM's scope has expanded further, addressing a wider range of risks, including foreign exchange risks, and has been adopted by non-financial companies to handle various financial exposures. Today, ALM plays a pivotal role at the intersection of risk management and strategic planning, guiding banks and insurance companies towards long-term strategic perspectives (Habart et al., 2015).

1.4 Missions of ALM

Asset-Liability Management (ALM) initially focused on effectively managing interest rate and liquidity risks to prevent imbalances between asset and liability cash flows. This approach employed concepts like liquidity gap analysis and mathematical metrics such as duration and convexity, as introduced by McCauley (Habart et al., 2015). It gave rise to ALM's immunization strategy, designed to minimize susceptibility to minor interest rate fluctuations. Consequently, ALM committees assumed central roles within financial institutions by collaborating with other departments.

In 1988, Basel rules expanded ALM's scope to include supervising equity risks alongside liquidity and interest rate risks. ALM became integral to bank management and was often incorporated into risk management departments.

ALM's key responsibility is harmonizing asset and liability management to optimize gains while managing risk in compliance with regulations. The ALM department provides vital data to the board of directors, enabling informed decisions through diverse economic scenarios (Habart et al., 2015).

In summary, ALM aims to align financial choices, optimizing the balance between gains and risks while adhering to regulatory mandates.

1.5 Objectives of ALM

In general, ALM aims to ensure appropriate coordination between assets and liabilities to achieve the financial objectives defined for a specific level of risk and within predetermined constraints. Thus, the ALM department of a bank is responsible for producing studies providing recommendations on business strategy and asset allocation (Merzouk, 2008).

However, the different definitions of ALM reveal that the opinions of the authors differ slightly as to the final objective of this approach. On the one hand, for some, the objectives of ALM are the following:

- Manageing the risks related to interest and exchange rates which weigh on the balance sheet of the bank;
- Managing liquidity needs related to banking activity;
- Preserving the bank's capital;
- Increasing bank profits.

On the other hand, according to other authors such as Bessis (2002), the objectives of ALM are more cautious. They do not refer to the last point mentioned above. On the contrary, ALM aims above all to ensure the sustainability of the financial institution by planning its development and funding, without considering the maximization of the institution's profitability as its main objective.

1.6 The place of ALM in the bank

The process of asset-liability management (ALM) may be conducted by various departments within a bank, including the Treasury department, ALM department, or other specialized units. In typical commercial banks, its role involves generating management reports

for review by the Assets and Liabilities Committee (ALCO). This committee, typically comprising risk managers from the bank and the head of the ALM or liquidity department, assists the Treasury head and the financial director in the risk management process, as outlined by Choudhry (2011).

Typically, the ALM reporting process is supervised by the bank's ALCO committee, which holds the responsibility of establishing and executing the ALM policy. During regular meetings, usually monthly, the ALCO examines the report in detail. Key items of interest in the ALCO report include changes in interest income, areas where income fluctuations are seen, and the latest near-term income projections. The ALM report makes the connection between these three aspects at the level of the group as a whole, as well as with each individual business line.

1.6.1 Objectives of the ALCO

The primary role of the ALCO committee is to assess the bank's comprehensive funding strategy. These assessments are documented in meeting minutes and disseminated to participants and designated stakeholders. ALCO members are tasked with conducting routine evaluations of the following aspects (Choudhry, 2011):

- The proportion of interest-sensitive assets to liabilities, gap ratios, risk ratios, and funding position.
- The bank's perspective on the anticipated interest rate levels and any corresponding adjustments made to the portfolio in response.
- ALCO's opinion on anticipated short-term and medium-term funding costs;
- Stress testing in the form of “what if?” scenarios, to assess the impact on the banking book of specific changes in market conditions;
- Possible adjustments to parameters should there be shifts in market conditions or alterations in risk tolerance.
- Existing loan and deposit interest rates, with a focus on ensuring their alignment with the broader lending and funding strategy.
- The breakdown of maturity profiles within the liquidity portfolio.
- The current and expected short and medium-term liquidity position.

The ALCO meets monthly, focusing on specific aspects each session. The agenda is set collaboratively, and policies must be adaptable. Only the committee can change policies, with deviations requiring approval from the CEO or the ALCO itself.

2 ALM process and techniques

Asset-Liability Management (ALM) stands as a pivotal component within the operations and risk management framework of any financial institution. It is vital for banks to acknowledge its significance and establish robust risk management protocols. The absence of ALM techniques leaves banks vulnerable to the constant evolution of financial risks. As a result, their profitability is put at risk, as was the case for numerous banks in the late 1970s and early 1980s (Ronil, 2014).

2.1 ALM process

ALM and treasury management should not be confused. While treasury management deals with liquidity and interest or foreign exchange positions, whether for its own account or on behalf of third parties, ALM focuses on interest margin and assumes liquidity, interest rate, foreign exchange and counterparty risks. Even though counterparty risk is often cited as the main explanation for bank profitability, it cannot be directly attributed to ALM (Coussergues et al., 2017).

In order to achieve the objectives highlighted by asset-liability management, the risk management process involves several fundamental steps and strategies (Houngbedji, 2018).

- **Step 1 : Risk Identification**
- Research and description of the entire spectrum of banking risks for the current and future period;
- Recording of risks according to their classification and key descriptions.
- **Step 2 : Assessment / Measurement**
- Identification of the main risks as a priority;
- Risk assessment using qualitative and quantitative methods;
- Calculation of risk profile indicators.

Liquidity, interest rate and foreign exchange positions provide a measure of the exposure of the bank to various risks. This measure applies over a fixed period that covers at least 3 to 6 months, but which can extend up to 1 year in synchronization with budget management (Coussergues et al., 2017).

- **Step 3 : Monitoring / Control**
- Analysis of levels and dynamics of risk profile measures;
- Control of risk triggers and limits;

- Calculation of margins and usage limits to take in more risks.

➢ **Step 4 : Reporting/Communication and Decision Making**

- Discussion of the results of risk control and monitoring;
- Setting priorities and chosing strategies for risk mitigation;
- Ensuring control of the execution of risk mitigation decisions.

While the previous steps are relatively mechanical, the appropriate choice will make all the difference, as it involves selecting among the various strategies the one that is not only the most realistic, but also that will generate the highest profitability for a predetermined level of risk, while complying with the bank's strategic guidelines in terms of areas of activity, products and size. In addition, in order to ensure a follow-up of the decisions taken, it is necessary to benefit from a certain flexibility in the structure of the balance sheet.

2.2 ALM Techniques

While multiple banks might employ comparable ALM techniques, each may utilize its unique system. Duration analysis and gap management represent the fundamental theoretical principles recommended for ALM.

2.2.1 Gap analysis

Gap analysis serves as a technique employed in asset-liability management to evaluate interest rate or liquidity risk. This method involves quantifying, at a particular point in time, the disparities between rate-sensitive liabilities (RSL) and rate-sensitive assets (RSA), which can also encompass off-balance sheet positions. These components are categorized based on timeframes, considering factors such as residual maturity or the next revaluation period, with a focus on the earliest date (Ronil, 2014). An asset or liability is considered rate sensitive if it meets one of the following conditions:

- It generates cash flows during the period considered;
- The interest rate is contractually adjusted during the period;
- The rates administered change;
- It can be redeemed early according to contractual conditions, or withdrawal is authorized before maturity.

Thus : **Gap = RSA – RSL**

2.2.2 Duration analysis

In managing interest-rate risk, gap analysis is often used alongside duration analysis. Duration gap quantifies the percentage change in a bank's equity market value in response to interest rate shifts. Assets with longer durations pose higher risk compared to shorter ones, and a wider duration spread indicates greater sensitivity of the bank's net worth to interest rate fluctuations. When asset duration exceeds that of liabilities, equity market value falls with rising interest rates but rises when rates fall. Conversely, with a zero duration spread, equity remains unaffected by rate changes. A larger positive or negative duration gap makes equity more responsive to rate shifts (Ghosh, 2012).

2.2.3 Scenario analysis

Simulations are a cornerstone in the decision-making arsenal of the Asset-Liability Management Committee (ALCO), offering valuable insights into future profitability and risk. These insights are instrumental in shaping business policies and hedging strategies. ALCO simulations encompass assessments of both interest rate and liquidity risks. Asset-liability management policies adopt a medium-term perspective, spanning at least 2-3 years to account for changes in the banking book driven by new business activities. Simulations provide several critical outputs, as articulated by Bessis (2002):

- They furnish projected values for key variables across diverse scenarios ;
- They gauge the bank's susceptibility to interest rate and liquidity risks ;
- They assist in optimizing the balance between risk and return by considering anticipated values and distributions of key variables in various scenarios.

Simulations represent a more intricate analysis compared to maturity and duration gap assessments, demanding a high level of technical expertise. The accuracy of simulation-derived insights hinges on the precision of assumptions and data reliability. Flawed assumptions or unreliable data can compromise results. Nevertheless, the simulation approach offers adaptability, allowing customization to meet specific user needs (Bessis, 2002).

3 Liquidity risk management using ALM

According to Bessis (2002), Liquidity risk emerges when there are disparities in the size and maturity profiles of a bank's assets and liabilities. When liquidity deficits exist, banks become susceptible to market liquidity risk. Having liquid assets at their disposal serves as a safeguard for banks during periods of market stress, as these assets offer an alternative means

to secure funds for meeting short-term obligations. When assets exceed available resources, deficits arise, requiring market funding. Conversely, when available resources exceed assets, the bank has surplus resources that can be lent or invested.

Liquidity risk management comprises four main stages, as illustrated in figure (2.1):

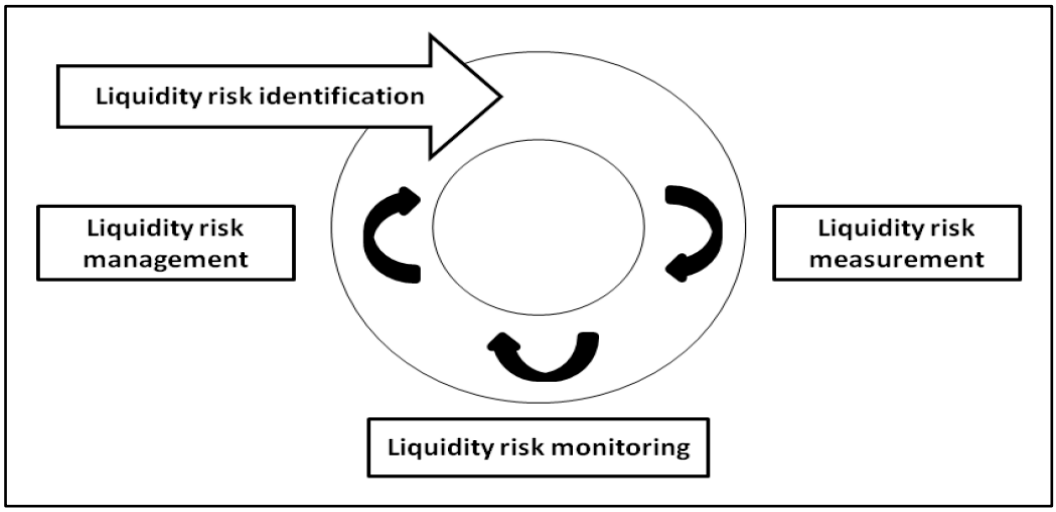


Figure 2: Stages of liquidity risk management *Author's work*

3.1 Liquidity risk identification

Through a detailed examination of a bank's assets and liabilities at a specific point in time, liquidity risk and its severity can be discerned by considering four key parameters (Ghosh, 2012):

- Ratios between specific components of assets and liabilities.
- The degree of reliance on volatile funding sources.
- The visibility of liquidity risk early warning indicators.
- The extent of liquidity gaps in the bank's financial structure.

3.1.1 Identifying liquidity risk in Assets

Liquidity risk may arise on the bank's assets as a result of market activities and the bank's day-to-day operations.

3.1.2 Market activities

These activities take the form of the bank's securities portfolio, which provides it with liquidity through: the maturity of a security and the sale of securities on the secondary market, which enables the bank to realize capital gains, and the temporary pledging of securities to obtain liquidity loans. It should not be forgotten that deteriorating asset prices lead to a decline in important sources of liquidity.

3.1.2.1 Banking activities

The main acts affecting bank liquidity requirements are cash inflows (income from loans, investments, loan disbursements and repayments) and cash outflows (funding existing lines of credit and granting new loans).

Banks are required to forecast cash outflows, taking into account hidden options in the bank's balance sheet, such as early repayments.

3.1.3 Identifiying liquidity risk in Liabilities

On the liabilities side, liquidity risk stems from the maturity profiles of deposits and the utilization of credit lines. It can also arise from funding risk and funding concentrations.

3.1.3.1 Funding risk

Represented by the possibility of sudden exhaustion of external sources of liquidity, these sources come from customer deposits (savings bonds, term deposits and sight deposits...etc.) or resources on the capital market. Generally speaking, funding risk can arise from :

- The possibility of massive withdrawals of deposits, as these have become very sensitive to changes in their rate of return and the degree of trust placed in the institution. These resources can therefore be withdrawn at any time to another establishment offering more favorable terms;
- The closure of a credit line on the interbank market, following the bank’s announcement by of any information adversely affecting its results or market position and/or following a downgrading by the rating agencies.

3.1.3.2 Funding concentration

Concentration risk is the risk of banks concentrating on one type of customer, one economic sector or one geographical area to finance their work, in which case a single decision can lead to massive or accidental withdrawals and thus change the bank's funding strategy.

3.1.4 Identifying liquidity risk in the off-balance sheet

Off-balance sheet items include commitments received or made on behalf of customers; after a significant outflow of funds, the appearance of these transactions may give rise to liquidity risks.

3.1.4.1 Funding commitments

These are commitments (credit lines) made to credit institutions and commitments made to bank clients (bank cards, cash credits, etc.). These commitments are capped, and once the bank keeps its promises, this will lead to capital outflows, creating liquidity risks.

3.1.4.2 Guarantee commitments

In these transactions, if the third party fails to meet all or part of its commitments, the bank will act as guarantor for the third party. They include sureties, endorsements and other guarantees.

3.1.4.3 Securities commitments

These relate to securities transactions to be delivered or received. The recording of these transactions occurs off the balance sheet on the transaction date and is subsequently reflected on the balance sheet as of the value date.

3.1.4.4 Foreign exchange commitments

These are spot or forward purchases of foreign currencies, not accounted for on the bank's balance sheet.

3.2 Liquidity risk measurement

Once the process of identifying liquidity risk is understood, it's essential to familiarize oneself with the various tools and methods for measuring this risk. The assessment of liquidity risk involves monitoring maturity and cash flow gaps. The liquidity measurement process should fulfill two primary objectives:

- To provide a continuous view of the liquidity position.
- To examine the evolution of the liquidity position under different scenarios and assumptions.

The measuring of liquidity risk depends on a number of tools, as is shown in the titles that follow.

3.2.1 Time buckets

Time profiles, also referred to as maturity profiles, are tables utilized to categorize assets and liabilities based on their maturities (Coussergues et al., 2017). These profiles offer insights into a bank's liquidity position at any given time, arranging balance sheet items by remaining maturity, spanning from shorter durations (days, weeks, months) to longer ones (years).

Banking authorities typically define the timeframes for classifying assets and liabilities, aligning with industry norms. However, minor variations may arise due to each bank's unique asset-liability structure. Assets and liabilities are allocated to these time categories based on projected cash flow schedules, helping identify disparities within each category (Ghosh, 2012).

Liquidity measurement primarily focuses on detecting cash flow imbalances in shorter timeframes, such as 0-7 days, 8-14 days, and 14-28 days. Assets and liabilities with fixed maturity dates, like term deposits and long-term loans, align with the corresponding buckets based on remaining maturities.

However, challenges emerge when categorizing assets and liabilities lacking fixed maturities, like current deposits and savings accounts. These flexible accounts may not adhere to contractual or residual maturities, necessitating a realistic allocation among time buckets (Ghosh, 2012).

3.2.2 Liquidity gaps

According to Choudhry (2018), a liquidity gap refers to the difference in maturity between assets and liabilities at each maturity along the term structure. In other words, liquidity gaps are the changes between the assets and liabilities of the banking book at all future dates. These differences create a liquidity risk. The latter situation arises when there is a shortfall of funds, as having an excess of funds exposes you to interest rate risk. This risk pertains to the uncertainty surrounding the rates that will apply to loans or investments involving those surplus funds. Consequently, there are two distinct types of liquidity gaps (Bessis, 2002) :

3.2.2.1 Static liquidity gaps

These liquidity gaps are solely influenced by the currently held assets and liabilities. They make it possible to assess the bank's liquidity position. The static liquidity gap reflects the current liquidity position of a bank and indicates the imbalance between the cash flows that are generated by the maturities of assets and liabilities. It is called "static" because it does not take into account expected changes in balance sheet items, but gives a snapshot of the liquidity position at a specific time. Thus, assets or liabilities that do not have a maturity date, such as stocks, funds or real estate, are not taken into account. Therefore, the static liquidity gap requires the identification of balance sheet items with a maturity date and the determination of expected cash flows for each item (Negret, 2009).

3.2.2.2 Dynamic liquidity gaps

They incorporate the amortization profiles of existing assets with projected new loans and new deposits (when projected lending and borrowing activities are taken into account). The objective of the dynamic liquidity gap is to provide a dynamic projection of liquidity indicators under normal conditions and stress scenarios, in order to identify and assess the costs, risks and benefits of the liquidity generated by each business unit (Negret, 2009).

It's worth emphasizing that these variances are treated as algebraic disparities between assets and liabilities, as outlined by Bessis (2002). Consequently, on any given date, a positive disparity between assets and liabilities signifies a deficit, while the reverse indicates a surplus. See figure (2.2) below.

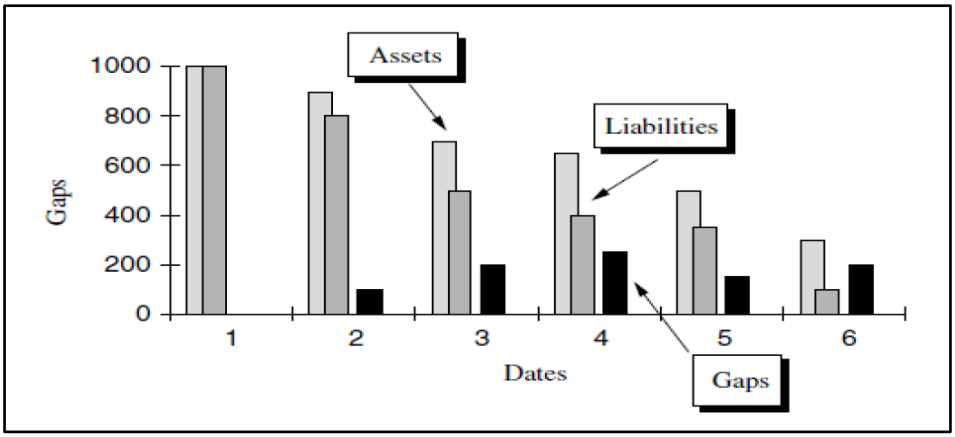


Figure 3 : Liquidity gaps *Taken from : Bessis, 2002.*

PS. The dynamic liquidity gap uses the same formulas as the static gap; however, the distinction lies in the fact that dynamic liquidity gaps make it possible to assess the strategic liquidity position based on anticipated cash flows from the entity's activities under different stress scenarios (Negret, 2009).

⇒ Liquidty gaps take two different forms : simple and marginal

- **Simple liquidity gaps** : According to (Roncalli, 2009), these are defined as the difference between assets and liabilities on a specific date, or vice versa. As is shown in the formula :

Simple liquidity gaps $_{(t)}$ **= Outstanding Assets** $_{(t)}$ **– Outstanding Liabilities** $_{(t)}$

It shall be noted that the opposite is also correct. If we adhere to this formula, a positive gap indicates a deficit that requires funding, whereas a negative gap suggests a surplus of resources available for investment.

The following table represents how simple liquidity gaps are measured :

Table 3: Simple liquidity gaps

Dates	1	2	3	4	5	6
Assets	1 000	900	700	650	500	300
Liabilities	1 000	800	500	400	350	100
Gaps	0	100	200	250	150	200

Taken from : Bessis, J. (2002).

- **Marginal liquidity gaps :** Marginal gaps, often referred to as incremental gaps, depict the variances in changes between assets and liabilities within a specified timeframe. A positive marginal gap indicates that, in algebraic terms, there is a greater increase in assets compared to liabilities. Conversely, when both assets and liabilities decrease over time, these changes are negative, and a positive difference signifies a cash outflow.

Marginal liquidity gaps = amortizations in assets – amortizations in liabilities[2]

The table (2.2) below is a more elaborate version of the precedent table. It gives an example on how marginal liquidity gaps are measured.

Table 4: Time profiles of outstanding assets and liabilities and of liquidity gaps

Dates	1	2	3	4	5	6
Assets	1 000	900	700	650	500	300
Liabilities	1 000	800	500	400	350	100
Gaps	0	100	200	250	150	200
Asset amortization	-	-100	-200	-50	-150	-200
Liability amortization	-	-200	-300	-100	-50	-250
Marginal gaps[3]	-	100	100	50	-100	50
Cumulative marginal gaps[4]	-	100	200	250	150	200

Taken from : Bessis, J. (2002).

In this example, both simple and marginal gaps are computed. Marginal gaps arise from changes in outstanding balances. Consequently, the cumulative sum of marginal gaps over time

[2] The term Amortization corresponds to the depreciation of both assets and liabilities. Liabilities "fall" when a bank repays a lender, while assets "fall" when customers repay a loan.
[3] Calculated by subtracting the algebraic changes in assets from those in liabilities between time t and t - 1. Therefore, a positive gap signifies an outflow, while a negative gap signifies an inflow.
[4] The cumulative marginal gaps equivalent to the gaps computed from the outstanding balances of assets and liabilities.

is equivalent to the gap calculated based on the outstanding balances of assets and liabilities (Bessis, 2002).

3.2.3 Liquidity risk indicators

According to academic literature (Saunders, 1997) and banking analysts, banks are recommended to use several liquidity indicators to assess their liquidity risks, among which are the following:

3.2.3.1 The funding gap

It is the difference between Average Loans and Average Deposits. If the funding gap is positive, the bank must look for sufficient funds to close it and bring the gap back to 0. An increase in the funding gap could indicate future liquidity problems if core deposits start to decline, making the bank increasingly dependent on borrowing from external markets (wholesale funds) to maintain a given volume of loans, at an unknown and potentially higher cost of funds. The latter is often taken as the ratio (main deposits/loans). A related indicator that we follow closely to assess a possible external vulnerability of the banking system is the loan-to-deposit ratio. [5]

3.2.3.2 The liquidity index

Also known as the "transformation index", It evaluates the disparity in maturities between assets and liabilities, which helps to determine the transformation risk incurred by the institution (Darmon, 1998). This index is calculated from assets and liabilities weighted by a coefficient representing the average duration of each category.

$$Liquidity\ Index = \frac{\sum \text{weighted liabilities}}{\sum \text{weighted assets}}$$

- When the index = 1, the assets and liabilities match perfectly.
- When the index > 1, the bank has an advantage in terms of resources. It borrows for the long term and lends for the short term.
- When the index < 1, the lower the index, the more the bank transforms short-term liabilities into long-term assets.

The following table is an elaborate illustrattion on how the transformation index is calculated:

[5] If this ratio is, for example, two, it indicates that 60% of the loans in the system rely on foreign borrowing (from the market or the parent bank) for funding. This high dependency on external sources makes the system highly vulnerable to rollover risks.

Table 5 : Liquidity index calculation

Period D	Liabilities	Assets	Weights	Weighted liabilities	Weighted assets
1 week	4 200	4 200	0.01	48	42
08 days ≤ D < 01 month	6 400	5 000	0.05	320	250
01 m ≤ D < 03 m	6 800	5 400	0.16	1 376	864
03 m ≤ D < 6 m	5 800	4 200	0.37	2 146	1 554
06 m ≤ D < 01 year	2 000	2 400	0.75	1 500	1 800
01 y ≤ D < 02 y	1 000	3 400	1.5	1 500	5 100
02 y ≤ D < 05 y	1 400	5 400	3.5	4 900	18 900
D > 05 years	1 500	4 000	7.5	11 250	30 000
Total	31 500	31 500		23 040	58 510

Taken from : Coussergues, et al., 2017.

As a result :

$$Liquidity\ Index = \frac{23\ 040}{58\ 510} \simeq 0.5$$

As the index is less than 1, this indicates that the bank faces high transformation risk, as it uses short-term resources to finance long-term assets. To deal with this situation, the bank must take measures to reduce this risk by acting in two ways:

- The first method concerns assets. The bank must sell some of its long-term assets to replace them with short-term assets;
- The second method concerns liabilities. The bank must sell some of its short-term liabilities to replace them with long-term liabilities (Coussergues, et al., 2017).

⇒ These liquidity risk measurement tools (time buckets, liquidity gaps and liquidity indicators) are often referred to as first generation tools. However, they have certain limitations and encounter several critical points which can be summarized as follows:

- Dealing with pending balances with uncertain maturities requires making generally unrealistic assumptions;
- The flows of liabilities depend on the behavior of the customer and the commercial policy of the bank, thus making their prediction difficult. They cannot be considered fixed.

3.2.4 Stress tests and simulations

Stress tests and simulations are integral components of risk assessment in the banking sector. Stress tests involve subjecting banks to various adverse scenarios, assessing their financial health, and measuring their resilience in the face of economic crises and severe market fluctuations, as outlined by Habart et al. (2015). These scenarios vary in severity and assist in establishing risk thresholds, capital allocation, exposure management, and contingency planning, as suggested by Ghosh (2012). Specifically, stress tests for liquidity risk aim to determine a bank's ability to maintain solvency, liquidity, and leverage levels during adverse conditions.

Simulations, as frequently employed by banks, play a critical role in liquidity risk management. They involve modeling different scenarios, as highlighted by Choudhry (2018), to evaluate risk levels, enhance funding and hedging strategies, and optimize the risk-return profile of the balance sheet, aligning with Bessis (2002). By combining stress tests and simulations, banks gain a comprehensive understanding of their vulnerabilities, evaluate risk exposure, and refine strategies to ensure financial stability and resilience in turbulent times.

3.2.5 Risk/Return pair

The two tools mentioned above make it possible to create matrices containing the results of the different hypotheses. These matrices, called margin matrices, present the average of the margin values obtained, their volatility, as well as a key indicator : Sharpe ratio, which corresponds to the average of the margins divided by the volatility.

⇒ The measurement tools mentioned (stress tests, simulations and the risk/return pair) are considered second generation tools. They stand out from first-generation tools because they integrate new future productions by performing simulations based on deterministic scenarios based on realistic assumptions.

3.3 Liquidity risk management and coverage

After going through the first two stages of asset-liability management, the bank now has to deal with liquidity risk to avoid any structural imbalance and ensure compliance with its commitments when they come due.

3.3.1 Liquidity risk management

The implementation of a good practice in terms of liquidity management at the bank is an essential step. This translates according to Greuning Van. H and Bratanovic. S.B (2004) by:

- Establishing of a risk management structure;

- Defining a liquidity management and funding strategy;
- Imposing a series of limits on exposure to liquidity risk;
- Establishing of liquidity planning procedures.

3.3.1.1 Risk management structure

This structure is responsible for setting up the conditions to be complied with, the procedures to be followed and decision-making in terms of liquidity management and the related risk. Furthermore, it structure must be attached to the top management level of the bank.

3.3.1.2 Defining a liquidity management and funding strategy

The banking risk management policy and its orientations, the funding conditions, i.e. the debts to be targeted, the pricing of deposits, the use of certain financial instruments, etc., are set at the level of this strategy, which must receive approval from the bank's board of directors.

3.3.1.3 Limitation of exposure to liquidity risk

It should be remembered that the maturities transformation activity exposes the bank to a significant liquidity risk. Indeed, this function must be limited to a threshold set and controlled by the general management in collaboration with the risk management structure, taking into consideration the strategy previously adopted and the bank's strategic and commercial orientations. In addition, the latter must put in place a policy to diversify its resources, something that will enable it to reduce its vulnerability to liquidity risk.

3.3.1.4 Liquidity planning

Liquidity planning is a crucial step in the management of liquidity risk since it is carried out by taking into consideration several possible scenarios, including that of a crisis. This allows the bank to protect itself against the adverse impacts of a prolonged liquidity crisis.

Following the simulation of the said scenarios and the assessment of their repercussions on the solvency and resilience of the bank, the general management in coordination with the risk management structure will take decisions and establish a contingency plan to prevent a possible situation of illiquidity.

3.3.2 Liquidity risk hedging

Identifying and assessing the magnitude of liquidity risk to which the bank is exposed enables it to define its funding policy while taking into consideration the regulatory constraints in force as well as its ability to raise new resources on the market. This policy guarantees the

bank better liquidity management, thus enabling it to avoid any need for liquidity and to guarantee good hedging of the related risk.

- **Liquidity risk hedging methods :**

There is a good number of techniques to ensure good hedging of the bank against liquidity risk.

➢ **Access to market resources**

The liquidity gaps that appear following a mismatch between the two balance sheet sizes can be managed and filled by raising new resources on the market or also by developing the activity of collecting deposits from customers, provided that the maturities of the latter correspond to those desired.

The profile of new resources, whether with the market or the clientele, must be set in such a way as to compensate for the discrepancies in question.

The fact that the cost of liquidity and the maturities of the operations go hand in hand, this hedging generates a cost. This is what Dubernet. M (2000) considers it to be the price of security.

➢ **A backing policy**

According to Bessis. J (2002), "backing is a basic concept in terms of liquidity and rate hedging. It is achieved when the amortization profiles of assets and liabilities are similar and when the reference rates are the same".

In this case, the liquidity backing technique consists of funding the bank's assets with liabilities (resources) of the same characteristics (maturity, reference rate, currency) in order to avoid any need for liquidity and to preserve balance sheet balance.

In addition, it is recommended according to Dubernet. M (2000) to practice the policy of backing liquidity from liabilities to assets, since this technique allows the bank to compensate for the phase shift between the two flows, and therefore to better manage its exposure to liquidity risk and to ensure better hedging of the latter.

A good matching practice results in a consolidation[6] of the balance sheet of the bank, on the other hand, in the absence of this technique, the balance sheet can be either over-consolidated or under-consolidated (Roncalli, 2009).

These two situations are presented in the following figures :

- Over-consolidated : as is represented in the figure below

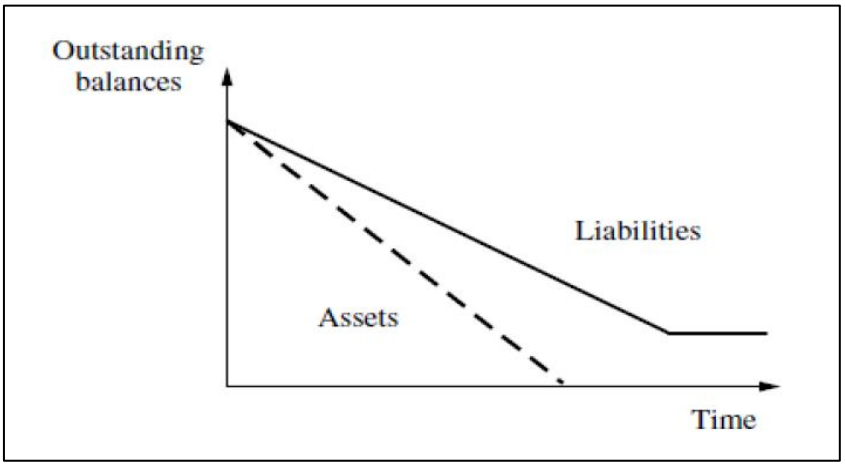


Figure 4 : Excess funds *Taken from : Bessis (2002)*

When assets depreciate faster than liabilities, this creates excess funds available to fund new operations. This observation comes from (Bessis, 2002).

- Under-consolidated : as is represented below

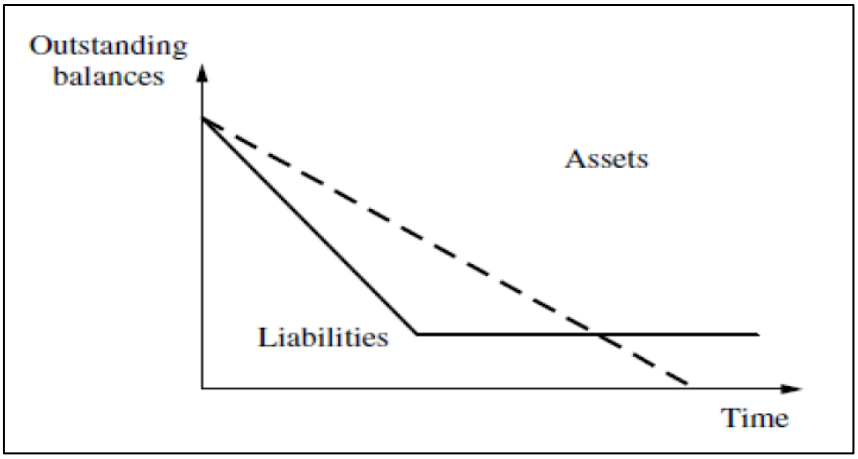


Figure 5: Deficits *Taken from : Bessis (2002)*

In this situation, liabilities depreciate faster than assets. The bank then finds itself in a context that requires funds in order to make up the shortfall with current assets. Quoted from (Bessis, 2002).

[6] We speak of a consolidated balance sheet when the maturities of assets and liabilities match "relatively well". In other words, it occurs when assets and liabilities depreciate at the same rate

- **Potential liquidity guarantees**

Potential liquidity guarantees represent a method of hedging against liquidity risk intended for banks that often intervene in the markets to ensure their funding. Indeed, as its name suggests, this technique offers the bank a guarantee to have new resources to cover its future loan production for a well-defined period.

Several instruments can be used in this context, we will cite two instruments, namely the standby guarantee and the underwriting of securities.

- **The standby guarantee:** this is an irrevocable commitment by a credit institution to guarantee the availability of resources as soon as the beneficiary requests it.
- **Securities underwriting guarantees:** this is a commitment by a bank syndicate to acquire all the securities issued as part of a bond loan before they are offered to the public and for a fee.

The bank sets the amount of its funding operations on the market according to its volume of activity to be covered over a pre-determined horizon.

- **Resorting to insurers**

In certain situations, resorting to insurers can help the bank cope with its liquidity risk and ensure its coverage, through funding guarantee lines signed between the insurance companies and banks.

- **Setting collection conditions during a period of interest rate decrease**

According to Dubernet. M (2000), credit institutions can use derivative products such as swap contracts to set collection conditions during a period of declining interest rates. They can also use options known as Cap options to protect them against a possible rise in interest rates and subsequently have resources at reduced rates. This allows them to limit their exposure to liquidity risk.

- **Prudential ratios**

These are the standards designed to reduce banks' exposure to various financial risks. Indeed, these ratios are established by the central bank and must be consistently adhered to by credit institutions in order to limit their transformation activity and preserve their financial soundness. Among these ratios, there is the Short-Term Liquidity Coverage Ratio (LCR) which aims to strengthen the bank's resilience in the face of a liquidity crisis, such as a massive withdrawal of funds, as well as the coefficient of own funds and permanent resources. However,

the bank can ensure better liquidity management and coverage of associated risk by internally establishing conditions and limits to be adhered to.

- **Securitization**

Securitization is a powerful balance sheet management tool. It is used in asset-liability management to manage both liquidity risk and interest rate risk. This refunding technique provides access to diversified resources, which reduces the liquidity risk for the bank.

By opting for securitization, the bank increases its liquidity and improves its risk profile, because the funding of loans is no longer provided by it, but by investors who have acquired shares in the common debt fund - Fonds Commun de Créances (FCC) (Coussergues, et al., 2017).

Conclusion

In order to overcome the challenges related to bank liquidity, a more robust and harmonized approach is now essential. Liquidity risk should be taken seriously as a major potential threat to the banking portfolio. To prevent a lack of liquidity that can lead to disastrous consequences, it is imperative to establish an efficient management strategy.

ALM is the solution adopted to meet these challenges. This holistic approach considers both sides of the balance sheet, namely assets and liabilities, to ensure an adequate balance. This will enable the bank to possess the required resources to cover its commitments and maintain a stable liquidity position. In addition, ALM offers tools for measuring financial risks, this includes addressing liquidity risk to minimize the adverse consequences linked to risk exposure.

By constantly monitoring its level of exposure to liquidity risk, the bank will be able to better anticipate and prevent critical situations. It is essential that the liquidity risk management process scrupulously respects the regulatory constraints and the institution's internal rules.

By adopting a proactive and rigorous approach to liquidity management, banks will be able to face future challenges with confidence and ensure their financial stability in an ever-changing economic environment.

CHAPTER THREE :
CASE STUDY, RESULTS & DISCUSSIONS

Introduction

Asset-Liability Management aims to put in place tools to be able to measure the exposure of the bank's balance sheet to different risks. After having developed the basic theoretical concepts, this final chapter will be dedicated to the practical application of the ALM approach within QNB.

To do so, we carried on a practical internship within the ALM Department of the bank. In order to quantify and assess QNB's exposure to liquidity risk, it is necessary to go through the construction of liquidity gaps, providing insight into future liquidity positions. This step requires a crucial analysis to define the amortization profiles and maturities of various balance sheet items. However, some of these items do not have contractual deadlines, posing challenges.

We will therefore conduct a statistical treatment of these items, more specifically : overdrafts, demand deposits and savings. Then, we will proceed to quantify the degree of exposure of Qatar National Bank to liquidity risk.

To carry out our work and respond to our problem, we deemed it useful to divide this chapter into four (04) sections:

- Presentation of the host organization;
- Diagnosis of QNB’s balance sheet ;
- Modeling of QNB’s non contractual elements;
- Measurement of the bank’s exposure to liquidity risk.

1 Presentation of Qatar National Bank Tunisia

1.1 Brief history of QNB Tunisia

The Qatar National Bank (QNB Group), founded in 1964 in Doha, Qatar, is a multinational bank operating in 31 countries. It has experienced notable expansion over the decades, playing a significant role in projects such as the financing of Doha International Airport in 1966 and the establishment of international branches in London in 1976.

In 2005, QNB launched an international expansion plan, extending its presence to over 24 countries and diversifying its services. The bank has successfully made strategic acquisitions, such as QNB ALAHLI in Egypt (2013) and QNB Finansbank in Turkey (2016), solidifying its position as a leading bank.

However, our main focus is on QNB Tunisia, founded in 1982 as a Tunisian-Qatari investment bank. This bank underwent a major transformation in 2013 when it adopted the name Qatar National Bank Tunisia following its acquisition by the QNB Group. This transition strengthened its position as the first bank to obtain approval from the Tunisian government to operate as a universal credit institution, moving beyond its initial role as an investment bank.

QNB Tunisia has actively participated in significant economic events, demonstrating its commitment to the community. In 2021 and 2022, the bank increased its capital as part of a comprehensive restructuring plan. As a Gold Sponsor of the 23rd edition of the International Forum of L'Economiste Maghrébin in 2022, it showcased its support for important economic initiatives in Tunisia.

The bank has also strengthened its operations by expanding its network and offering diversified financial services. With a vision to become a leading institution in Africa, the Middle East, and Southeast Asia, QNB Tunisia actively contributes to this growth strategy.

With a commitment to operational excellence, integrity, transparency, and social responsibility, QNB Tunisia remains a driving force in the Tunisian banking sector, supported by the resources and expertise of the QNB Group.

1.2 The current situation of QNB

1.2.1 The Net Banking Income (NBI)

The net banking income is an indicator that reflects the value created by the activities of the banking institution. It is obtained by calculating the difference between bank operating revenues and expenses.

Table 6 : NBI evolution (in thousands of TND)

Year	2020	2021	2022
Operating revenues	103 966	101 922	126 554
Operating expenses	98 087	75 604	88 241
Net Banking Income	5 879	26 318	38 313

Taken from : QNB's 2022 income statement

The upward trend in QNB's net banking income over the past three years is a positive sign, and it appears to be primarily driven by an increase in revenues. To sustain and further enhance this growth, QNB should continue to focus on revenue-generating strategies, efficient operations, and prudent financial management. Additionally, ongoing monitoring of market conditions and adaptation to changing circumstances will be crucial to maintaining this positive trajectory.

1.2.2 The Operating Expense Ratio

It refers to a financial metric used to assess the efficiency of a company or organization by comparing its operating expenses to its revenue. This ratio helps understand how effectively a company is managing its operating costs relative to its income.

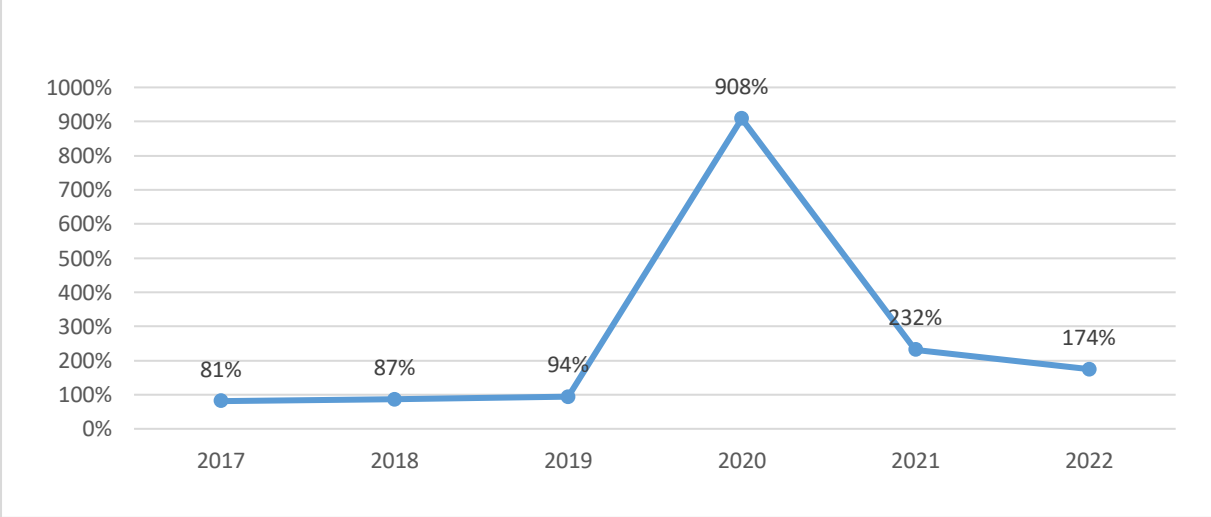


Figure 6: Operating Expense Ratio Evolution *Author's work using QNB's financial statements*

The operating expense ratio of QNB Tunisia exhibited significant fluctuations over the past six years. In 2017, the ratio stood at 81%, indicating that the bank's operational expenses accounted for a relatively low proportion of its revenues. However, this ratio saw a notable increase, reaching 87%, then 94% in 2018 and 2019 respectively, signifying a higher cost burden on the bank's operations. In 2020, there was an unusually high spike in the operating

ratio, reaching 908%. This can be attributed to the bank's low Net Banking Income (NBI) for the year, causing the ratio to elevate significantly. The operating ratio is calculated by dividing the bank's operating expenses by its NBI, resulting in a ratio of 908% (53,402 / 5,879).

In 2021, the ratio remained elevated at 232%, suggesting continued challenges in managing operational costs. However, there was a positive improvement in 2022, with the ratio declining to 174%, reflecting efforts to streamline expenses and improve operational efficiency.

1.2.3 Return on Assets (ROA)

The asset turnover ratio (ROA) allows us to assess the economic profitability generated by the bank from its assets. The calculation of this indicator involves the ratio between net income and total assets.

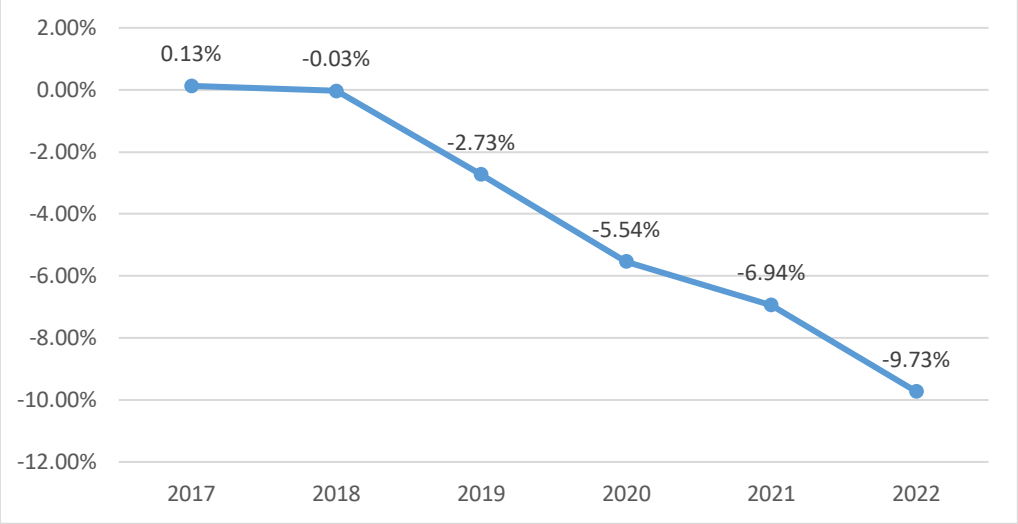


Figure 7: ROA evolution *Author's work using QNB's financial statements*

Analyzing QNB Bank's ROA data from 2017 to 2022 reveals a concerning trend. In 2017, the bank had an ROA of 0.13%, indicating a modest profitability. However, this trend turned negative in 2018 with an ROA of -0.03%, suggesting challenges in effectively utilizing its assets to generate earnings. The situation worsened significantly in the subsequent years, reaching a value of -9.73% in 2022. These negative values indicate that the bank's assets are not generating enough profit to cover its expenses, potentially reflecting operational inefficiencies, increased costs, or poor asset quality.

In summary, QNB Bank's declining ROA over the years suggests a need for a comprehensive assessment of its financial strategies, asset management, and cost control measures to improve profitability and long-term sustainability.

1.2.4 Return on Equity (ROE)

The Return on Equity (ROE) is a key financial indicator that reflects a company's profitability relative to its shareholders' equity. The calculation of this ratio (ROE) consists of dividing the net income by the equity invested by the shareholders.

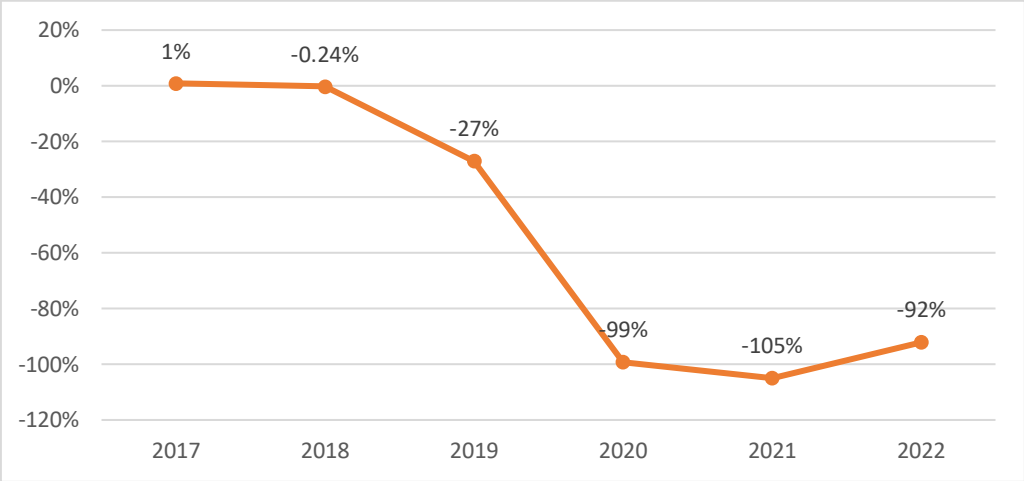


Figure 8 : ROE evolution **Author's work using QNB's Financial statements**

In the case of QNB bank, the ROE data for the years 2017 to 2022 paints a concerning picture. In 2017, the bank reported a modest ROE of 1%, indicating reasonable profitability. However, this positive trend took a downturn in subsequent years. In 2018, ROE turned negative to -0.24%, indicating a loss relative to shareholders' equity. The situation worsened significantly the following years, reaching -105%, in 2021. These extreme negative values indicate substantial losses that may have been influenced by adverse economic conditions (Covid-19), operational challenges, or financial decisions.

1.3 The principal regulatory ratios

1.3.1 The solvency ratio

Despite the downward trend in the solvency ratio of QNB Bank of Tunisia, it is crucial to note that the solvency ratio has consistently remained above the Central Bank of Tunisia's mandated minimum requirement of 10% for the capital ratio. This adherence to the regulatory threshold reflects the bank's proactive approach to maintaining a sound financial position during the year 2022, which is essential for ensuring the stability and resilience of the banking sector.

While the bank should keep an eye on the decreasing trend and consider making strategic changes if needed, the fact that the bank has maintained a solvency ratio above the regulatory threshold is a positive sign. It indicates the bank's commitment to careful financial management and risk reduction.

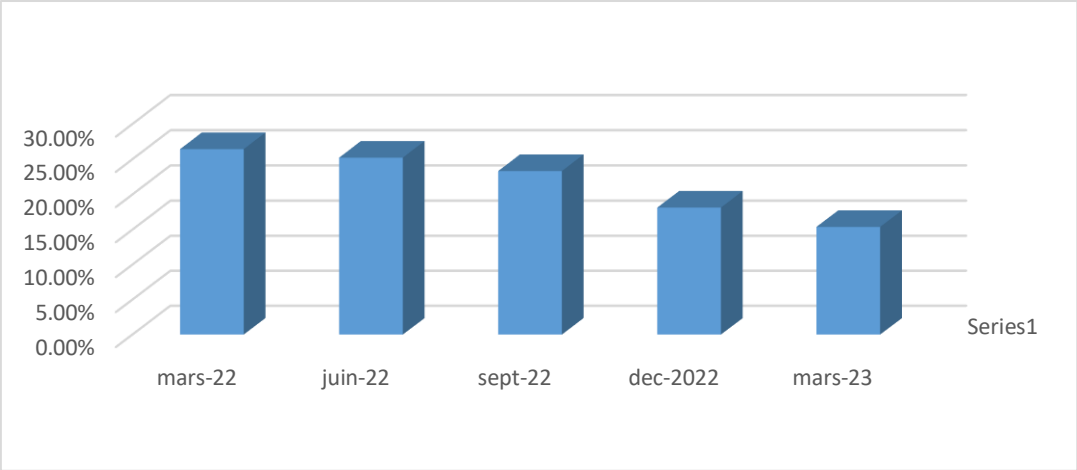


Figure 9: Solvency ratio evolution *Taken from : QNB's Liquidity risk report 2023*

1.3.2 The liquidity Coverage Ratio (LCR)

The LCR is a regulatory requirement for banks to hold a sufficient amount of high-quality liquid assets to cover potential short-term liquidity disruptions, ensuring their stability during financial stress or crises.

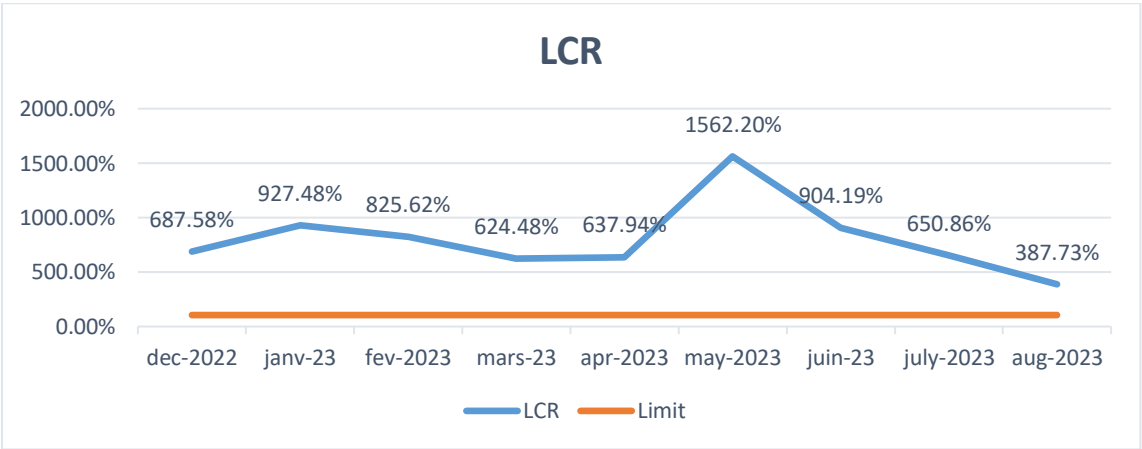


Figure 10: Monthly evolution of LCR *Taken from : QNB's Liquidity risk report 2023*

QNB's liquidity coverage ratio has shown significant fluctuations over the months. In December 2022 and January 2023, it was considerably high, reaching 687.58% and 927.48%, respectively. However, in the subsequent months, it experienced a noticeable decline, falling to 825.62% in February, 624.48% in March, and 637.94% in April. May saw a dramatic spike to 1562.20%, which was followed by a gradual decrease in June (904.19%) and July (650.86%). By August 2023, the LCR had dropped to 387.73%. It is important to note that these percentages are well above the minimum requirement of 100% set by the Central Bank of Tunisia (105% in

QNB's case)[7]. QNB appears to have faced varying liquidity challenges during this period but consistently maintained a robust LCR, comfortably surpassing regulatory expectations.

1.3.3 Net Stable Funding Assets (NSFR)

The NSFR is a regulatory metric that assesses a bank's long-term stability by comparing its available stable funding with its required stable funding. It aims to ensure that banks have enough long-term funding to support their assets and liabilities over a one-year horizon, promoting financial stability.

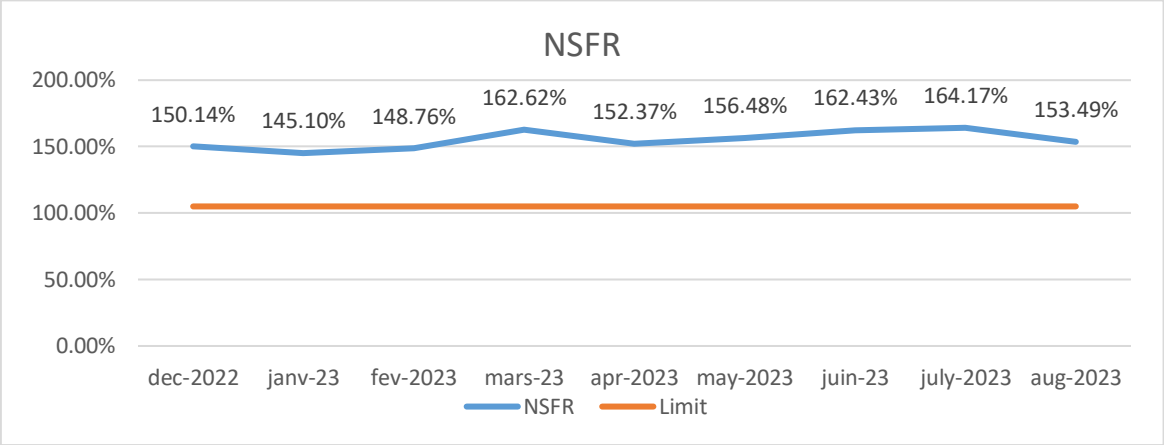


Figure 11: Monthly evolution of NSFR *Taken from : QNB's liquidity risk report 2023*

The Net Stable Funding Ratio (NSFR) data for QNB Bank from December 2022 to August 2023 indicates the bank's ability to maintain a stable funding profile over various timeframes. During this period, the NSFR consistently remained above 105% [8], reflecting the bank's ability to fund its assets efficiently in the long term, reducing the risk of liquidity mismatches. The ratio peaked in March 2023 at 162.62%, suggesting a robust liquidity position at that time. Overall, the trend of NSFR percentages above the regulatory minimum indicates QNB Bank's commitment to maintaining a solid and stable funding structure, which is crucial for the bank's resilience in the face of potential financial stress and market volatility.

[7] Individual banks can choose to set their own internal risk management standards that exceed the regulatory minimum requirements. Setting a higher minimum LCR, such as 105%, is a strategic decision made by QNB Tunisia for several reasons: risk management, competitive advantage, …etc.

[8] While the Basel III framework provides a minimum requirement of 100% for NSFR, it allows individual banks some flexibility to set more stringent requirements if they see fit. In the case of QNB's Tunisian branch, setting their NSFR minimum at 105% indicates that they have chosen to maintain a more conservative funding profile than the regulatory minimum of 100%. There could be several reasons for this: risk management, business strategy, …etc.

1.3.4 Loan To Deposit (LTD)

The loan-to-deposit ratio is a financial metric used to assess the liquidity and lending practices of a bank or financial institution. It is calculated by dividing the total loans held by the bank by its total deposits.

In accordance with the provisions of the BCT's circular n°2018-10 of November 1, 2018, all banks are required to respect a credit/deposit ratio within the limit of 120%. Otherwise, banking establishments must take corrective measures to mitigate this ratio.

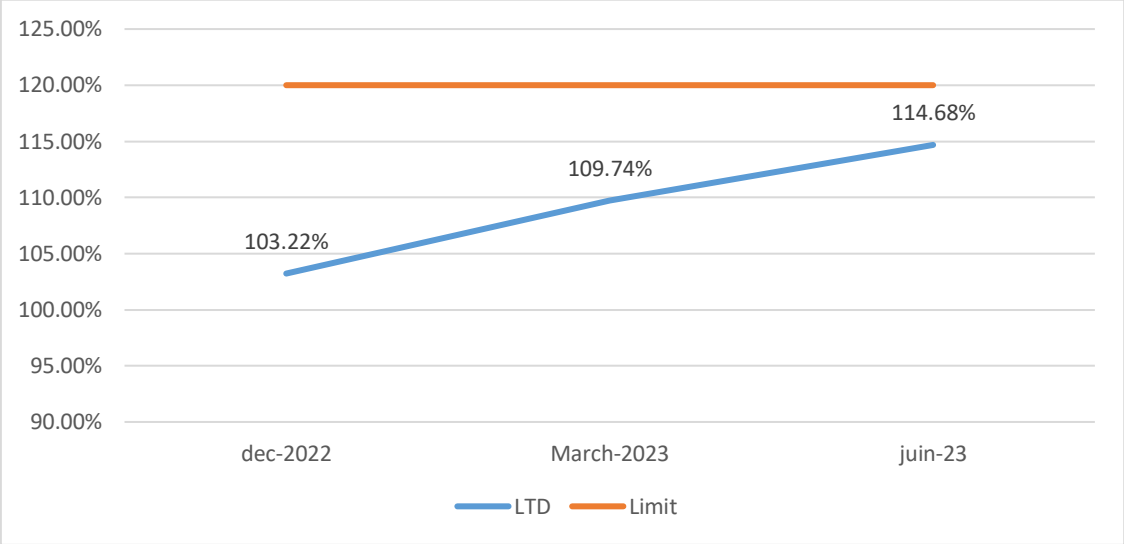


Figure 12 : Quarterly evolution of LTD *Taken from : QNB's liquidity risk report 2023*

QNB's LTD has shown a steady increase over the past few months. In December 2022, the ratio stood at 103.22%, indicating that the bank's outstanding loans were slightly above its total deposits. However, this ratio saw a notable uptick in March 2023, reaching 109.74%, suggesting that the bank had extended more loans relative to its deposit base. This trend continued into June 2023, with the LTD ratio climbing to 114.68%. While a rising LTD ratio can indicate increased lending activity, it's essential for the bank to strike a balance to ensure it maintains liquidity and minimizes risks associated with excessive lending. In fact, it shall be noted that without having resorted to external financing operations, the bank would not have had the capacity to meet its needs.

2 Diagnosis of QNB's balance sheet

Effectively addressing liquidity risk necessitates a well-researched strategy, which is particularly crucial for financial institutions like banks, with a primary focus on the Asset and Liability Management department. In this context, it is imperative to follow a comprehensive approach when conducting a liquidity risk assessment related to QNB's 2022 financial statement. This analysis involves several key stages:

- Thorough Examination of the Balance Sheet: This involves a comprehensive review of both assets and liabilities.

- Development of Time-Buckets (Maturity Profiles) and Amortization profiles for Assets and Liabilities: Creating a structured framework that outlines the maturity profiles and amortization schedules of assets and liabilities.

By adhering to these steps, the bank can ensure a well-informed and systematic approach to managing liquidity risk while maintaining originality in its risk management practices.

- **Hypotheses followed by the bank :**

Before proceeding to analyze the elements of the balance sheet, it is crucial to underline that the balance sheet items used in the calculation of the gap are defined within the framework of the following hypotheses, as followed by the bank:

- Adoption of the cessation-of-activity hypothesis for all elements (including those with no defined maturity such as overdrafts, demand deposits and savings). This is a cautious view that considers that non-maturing items will disappear overnight.
- Off-balance sheet items are not taken into account in this analysis due to the difficulty in determining the characteristics of the flow of this type of commitment.
- Only the assets and liabilities closed as of 31/12/2022 are considered in the calculation of the gaps.

2.1 Analysis of Assets

As of 12/31/2022, we note that the bank's assets are essentially composed of customer loans with a percentage of 54% of the total balance sheet. The details regarding assets are cited in the following figure.

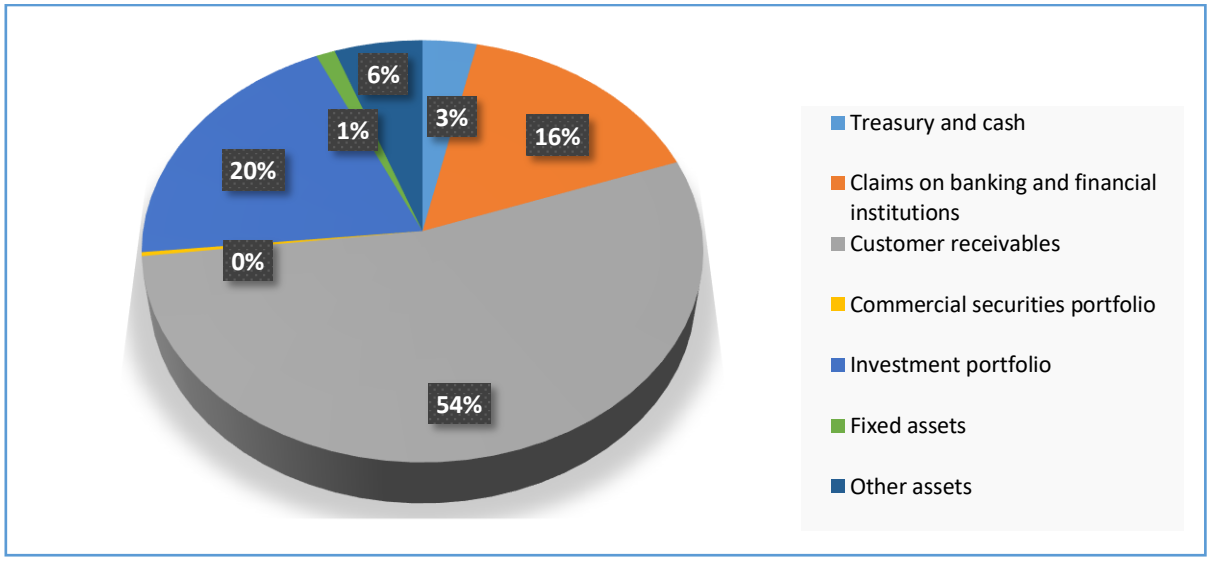


Figure 13 : Composition of the balance sheet's assets *Taken from : QNB's 2022 balance sheet*

2.1.1 Treasury and cash

This highly liquid asset item represents all the cash (notes and currencies) of QNB at the treasury, the Central Bank, the Post Office and the Public Treasury of Tunisia. It should be mentioned that part of its assets relate to mandatory reserves which, by its regulatory nature, must be classified as long-term in terms of maturity profile.

This item represents 20 % of the balance sheet total, with an amount of 57 716 KTND as of 12/31/2022. Its time bucket is illustrated by the table below :

Table 7 : Time bucket of treasury and cash (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**57 716**	-
< 3 months	0	**57 716**
[3 - 6 months[	0	0
[6 months - 1 year[	0	0
[1 - 2 years[	0	0
[2 - 5 years[	0	0
[5 -7 years[	0	0
> 7 years	0	0
Total		**57 716**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.1.2 Claims on banking and finanacial institutions

The weight of this balance sheet section out of its total is 16 %, i.e. a balance of 270 481 KTND as of 12/31/2022. This asset item mainly assembles together two subaccounts. The first

corresponds to receivables from banking and financial institutions, these are interbank loans which have a well-defined maturity (on sight or at term). As for the second sub-account, it is associated with the bank's holdings in other banking and financial institutions. The time profile by due date for this item is as follows :

Table 8 : Time bucket of Claims on banking and financial institutions (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**270 481**	-
< 3 months	42 099	228 382
[3 - 6 months[	40 974	1 125
[6 months - 1 year[	5 917	35 057
[1 - 2 years[	3 500	2 417
[2 - 5 years[	0	3 500
[5 -7 years[	0	0
> 7 years	0	0
Total		**270 481**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.1.3 Customer receivables

Receivables from customers represent 54% of the balance sheet's total, i.e. the largest weight in terms of Assets with an outstanding amount totaling 903 935 thousand TND as of 12/31/2022. This balance sheet section includes all net credits granted to individuals and legal entities as well as the balance of the various overdraft current accounts. The time bucket for this item is illustrated in the table below :

Table 9 : Time bucket of customer receivables (in thousands of TND)

Period	Overdrafts	Remaining receivables	TOTAL
< 3 months	38 714	198 870	237 584
[3 - 6 months[	0	71 827	71 827
[6 months - 1 year[	0	43 612	43 612
[1 - 2 years[	0	101 585	101 585
[2 - 5 years[	0	206 485	206 485
[5 -7 years[	0	17 564	17 564
> 7 years	0	232 428	232 428
Total	38 714	872 371	911 085

Taken from : QNB's consolidated time buckets of 12/31/2022

As we can see, since the bank considers that overdrafts have no real contractual maturity, it records its amortization overnight (in the first time bucket), this leaves no space for accuracy and precision.

2.1.4 Commercial securities portfolio

The item "Commercial Securities Portfolio" consists primarily of Fungible Treasury Bills (T-bills). These treasury bills are held by QNB with the aim of realizing short-term capital gains. The breakdown of this item is detailed in the following table :

Table 10 : Time bucket of commercial securities portfolio (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**5 074**	-
< 3 months	5 074	0
[3 - 6 months[	5 074	0
[6 months - 1 year[	0	5 074
[1 - 2 years[	0	0
[2 - 5 years[	0	0
[5 -7 years[	0	0
> 7 years	0	0
Total		**5 074**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.1.5 Investment portfolio

The item Investment portfolio or "Investment Securities Portfolio" consists of investment securities, SICAR investment securities, as well as QNB's ownership stakes in its affiliates. These securities are held on a long-term basis by QNB due to their strategic importance. They constitute 20% of the total balance sheet.

Table 11 : Time bucket of investment portfolio (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**340 591**	-
< 3 months	187 741	152 850
[3 - 6 months[	187 741	0
[6 months - 1 year[	131 297	56 444
[1 - 2 years[	126 297	5 000
[2 - 5 years[	68 375	57 922
[5 -7 years[	2 515	65 860
> 7 years	0	2 515
Total		**340 591**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.1.6 Fixed assets

The "Fixed Assets" category consists of the assets held by QNB, including real estate properties and land, office and transportation equipment, computer software, and goodwill. These assets are essential for the bank's operations and, therefore, have a long-term maturity.

The time profile of this item is as follows:

Table 12 : Time bucket of fixed assets (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**20 173**	-
< 3 months	15 845	4 328
[3 - 6 months[	15 355	490
[6 months - 1 year[	14 427	928
[1 - 2 years[	12 772	1 655
[2 - 5 years[	9 392	3 380
[5 -7 years[	8 546	846
> 7 years	0	8 546
Total		**20 173**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.1.7 Other assets

Within a company's balance sheet, 'other assets' refer to a heterogeneous set of non-cash, non-current assets. These assets, while diverse, contribute to the company's overall financial health and operational capacity. In QNB's case, this item makes up 6% of the total balance sheet. The breakdown of this item is detailed in the following table :

Table 13 : Time bucket of other assets (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**53 883**	-
< 3 months	42 537	11 346
[3 - 6 months[	41 683	854
[6 months - 1 year[	39 161	2 522
[1 - 2 years[	34 836	4 325
[2 - 5 years[	23 660	11 176
[5 -7 years[	18 466	5 194
> 7 years	0	18 466
Total		**53 883**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.2 Liabilities analysis

We note that the liabilities of QNB are essentially composed as of 12/31/2020 of customer deposits and funds with a percentage of 79 % of the balance sheet's total. The details of the liabilities are cited in the following figure.

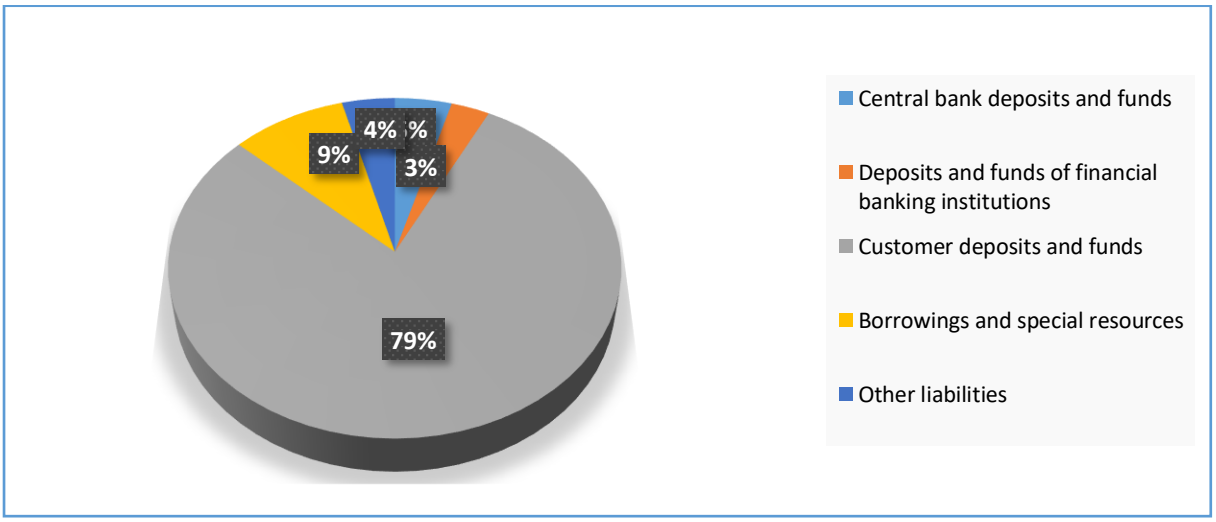


Figure 14: Composition of the balance sheet's liabilities *Taken from : QNB's 2022 balance sheet*

2.2.1 Central bank deposits and funds

In an economy facing liquidity challenges, Tunisian banks often resort to demand deposits to meet regulatory reserve requirements. This explains the positive balance of this liability account. It accounts for 5% of the bank's total assets, with a balance of 67 002 thousand dinars as of 12/31/2022. However, due to its high demand nature, this balance sheet item is amortized in the very short term. The time profile by due date for this item is as follows :

Table 14 : Time bucket of central bank deposits and funds (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**67 002**	-
< 3 months	0	67 002
[3 - 6 months[	0	0
[6 months - 1 year[	0	0
[1 - 2 years[	0	0
[2 - 5 years[	0	0
[5 -7 years[	0	0
> 7 years	0	0
Total		**67 002**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.2.2 Deposits and funds of financial banking institutions

As its name suggests, this item comprises two sub-accounts. The first includes all deposits from banking and financial institutions, and the second sub-account contains loans contracted by QNB in the interbank market. The balance of this item as of the end of 2022 amounts to TND 45 452 KTND which represents 3 % of the total balance sheet. The following table outlines the time profile of this item :

Table 15 : Time bucket of financial banking institutions (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**45 452**	-
< 3 months	**20 000**	25 452
[3 - 6 months[	0	20 000
[6 months - 1 year[	0	0
[1 - 2 years[	0	0
[2 - 5 years[	0	0
[5 -7 years[	0	0
> 7 years	0	0
Total		**45 452**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.2.3 Customer deposits and funds

This category includes demand deposits (DDs), savings deposits, maturity deposits, and other customer deposits and funds. To better represent the composition of this liability element, here are its components explained in detail :

- **Demand Deposits (DDs)** : also known as Checking and Current accounts, they represent cost-free or low-interest-bearing resources, subject to potential withdrawals by depositors at any time, making it challenging to predict customer withdrawals. Contractually, DDs have a one-day maturity, but in practice, we observe a certain stability over time.
- **Savings deposits (SDs)**: they consist of special savings accounts (SSA) as well as other savings accounts (housing savings, education savings, etc.). These savings deposits are interest-bearing, but their maturity is indefinite.
- **Maturity deposits** : these have well-defined maturities (established in the bank's contract with the client). These resources are more stable than DDs and SDs, explaining their higher cost.

It should be noted that DDs and Savings represent a significant part of the low-cost resources available to banks whose main activity consists of transforming these deposits into credits. However, these resources have no contractual maturity since the client can withdraw all or part of the deposit at any time, without notice or penalty. This imposes a cost on the bank in the form of an increase in liquidity and interest rate risk.

The stability of deposits therefore appears to be a fundamental condition for guaranteeing sustainable growth of the bank. Hence the need to study and measure this stability for deposits and to distinguish the part of stable deposits from the unstable or volatile one. It is exactly why both demand deposits and savings deposits are segmented into :

- **Stable deposits** : these are deposits that have a high probability of remaining on the balance sheet for a long time ;
- **Primary deposits** : these are deposits which are both stable and very insensitive to rate variations ;
- **Volatile deposits** : these are deposits which risk quickly leaving the bank's balance sheet plus those highly sensitive to rate variations.

This segmentation is in accordance with the Basel framework, and it concerns individual customers, large companies, SMEs and VSEs.

To have an idea on the stability of these elements, as mentioned earlier, we proceeded to segment both DDs and SDs as follows :

- **Segmentation of Demand deposits according to their stability :**

There are several methods for dealing with these deposits. J Bessis' graphical method is the most realistic approach. It considers that demand deposits are composed of a stable part and a volatile part, with the former being long-term and the latter being short-term.

This method is based on a charting that traces the evolution of the historical series of demand deposits over a temporal horizon. The stable part of demand deposits is equal to the minimum recorded during the period under study (2019-2023). According to the chart of the evolution of QNB’s DDs, it amounts to 286 764 282 DZD.

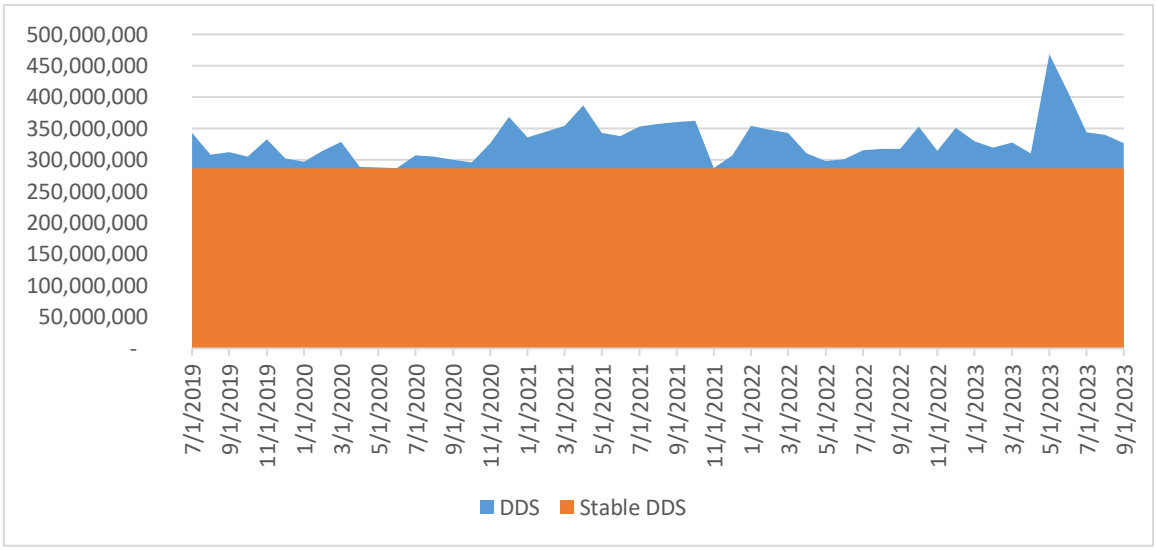


Figure 15: Segmentation of demand deposits *Author's work using QNB's internal data*

- **Segmentation of Savings according to their stability :**

We follow the same approach used previously with demand deposits.

The stable part of savings is equal to the minimum recorded during the same study period. According to the chart of the evolution of QNB's Savings, it amounts to 63 450 925 DZD.

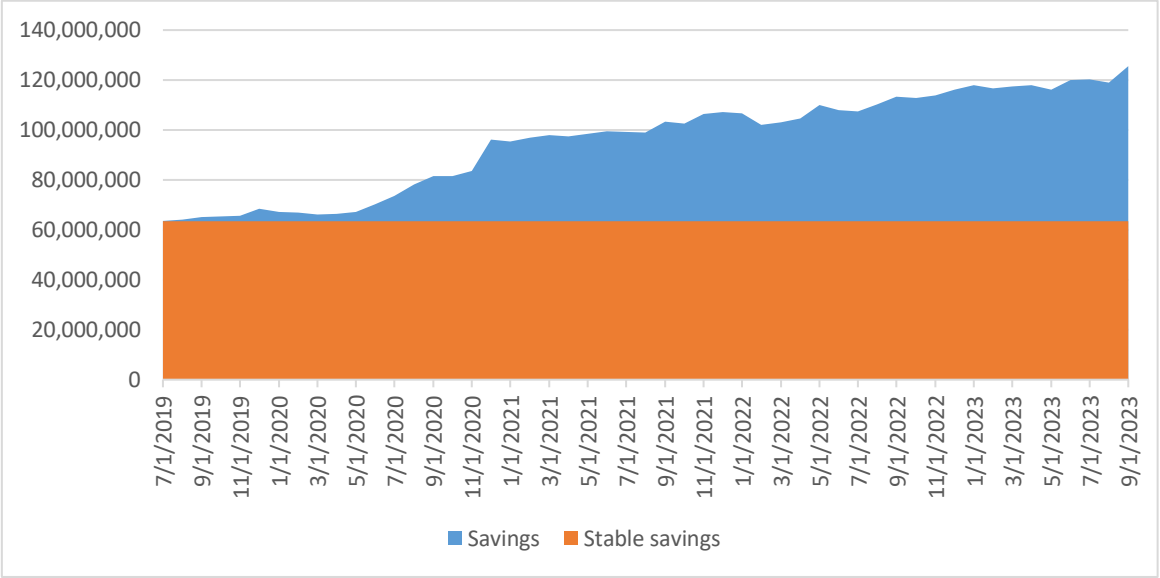


Figure 16 : Segmentation of savings *Author's work using QNB's internal data*

In QNB's case, the total Customer Deposits and funds accounts for 79% of the total balance sheet, with a value of 1 203 071 thousand dinars as of 12/31/2022. The time bucket of this item is showed in the following time bucket. Since the bank considers that both Demand deposits and Savings have no contractual maturity, it registers their amortizations overnight (in the first time bucket), which leaves very little room for detail and accuracy:

Table 16 : Time bucket of customer deposits and funds (in thousands of TND)

Period	DDs	Savings	Term deposits & others	TOTAL
< 3 months	347 592	116 122	356 635	820 349
[3 - 6 months[	0	0	89 881	89 881
[6 months - 1 year[	0	0	189 665	189 665
[1 - 2 years[	0	0	50 271	50 271
[2 - 5 years[	0	0	51 905	51 905
[5 -7 years[	0	0	1 000	1 000
> 7 years	0	0		0
Total	347 592	116 122	739 357	1 203 071

Taken from : QNB's consolidated time buckets of 12/31/2022

2.2.4 Borrowings and special resources

As of 31/12/2022, the total balance of this item amounts to 136 227 thousand dinars representing 9% of the total balance sheet. These are resources collected through bonds issued by QNB as well as special resources represented by foreign and government credit lines. The table below outlines the time bucket of this liability item :

Table 17 : Time bucket of borrowings and special resources (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**136 227**	-
< 3 months	108 799	27 428
[3 - 6 months[	90 035	18 764
[6 months - 1 year[	38 749	51 286
[1 - 2 years[	1 222	37 527
[2 - 5 years[	72	1 150
[5 -7 years[	0	72
> 7 years	0	0
Total		**136 227**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.2.5 Other liabilities

Other liabilities encompass various obligations not categorized elsewhere. These may include deferred revenues, accrued expenses, and miscellaneous liabilities, reflecting a diverse range of financial obligations. It should be noted that this item, with a balance of 62 212 KTND

as of 12/31/2022 (4 % of the total balance sheet), will be amortized in full due to its low degree of exigibility.

Table 18 : Time bucket of other liabilities (in thousands of TND)

Period	Outstanding	Amortization
Dec 31st 2022	**60 739**	-
< 3 months	5 380	55 359
[3 - 6 months[	5 380	0
[6 months - 1 year[	5 380	0
[1 - 2 years[	5 380	0
[2 - 5 years[	5 380	0
[5 -7 years[	5 380	0
> 7 years	0	5 380
Total		**60 739**

Taken from : QNB's consolidated time buckets of 12/31/2022

2.3 Equity analysis

Shareholders' equity represents the residual interest in the assets of a company after deducting its liabilities. In simpler terms, it is the portion of a company's assets that belongs to the shareholders (owners) after all debts and obligations have been settled. Shareholders' equity is often composed of common stock, retained earnings, and additional paid-in capital, and it serves as a measure of the company's net worth or book value.

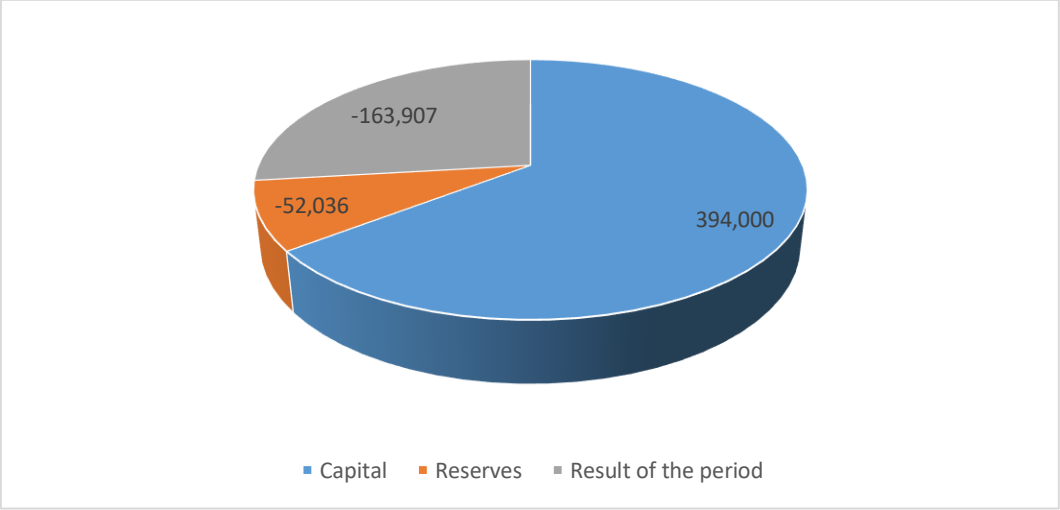


Figure 17 : Shareholders' equity *Taken from : QNB's 2022 balance sheet*

The figure above further details the components of the bank's equity as of 12/31/2022. We note that the latter is essentially composed of capital, with an amount of 394 000 KTND.

Capital here refers to common stock or share capital, it is a component of shareholder equity that represents the initial investment made by shareholders in the company through the purchase of shares. The other two elements are the result of 2022 and the reserves. As is shown in the figure, both elements and of a negative value, indicating that the bank is experiencing financial difficulties and challenges.

In fact, the shareholders' equity of a bank does not have a specific flow or maturity date like debts or loans. Shareholders' equity represents the residual value of a company's assets after all debts and obligations are deducted, and it is not subject to repayment or maturity. It is considered the ownership of the shareholders and can fluctuate based on the company's performance, but it does not need to be repaid like debt.

3 Modeling of QNB's non contractual elements

As mentioned in the previous section, adoption of the cessation-of-activity hypothesis on all balance sheet items, including the non contractual ones leaves room for very little accuracy and detail. Therefore, the results of the time profile developments risk to be unreliable for the bank to know its real liquidity position and on which spectrum it actually falls.

For that reason, we will suggest to exclude the three non contractual balance sheet items from the last hypothesis (cessation-of-activity), namely, debit current accounts (overdrafts), demand deposits and savings. These items will be projected into the future based on their developments determined by statistical models. Unlike the cautious view that considers that non-maturing items will disappear overnight, we will adopt a more realistic approach by admitting that these items remain stable over time and that based on their history, we can forecast their new productions.

3.1 Modeling of QNB's Overdrafts

A debit current account is an account with a debit balance. It offers a loan or an advance, both for individual customers and for professionals, with express authorization from the bank within well-defined limits.

Not all overdrafts can be repaid on a specific date. For this purpose, a modeling of this asset item provides us with an idea of its future evolution. The study sample is made up of 52 monthly observations of overdraft balances over the period from July 2019 to September 2023.

To conduct the modeling, we first relied on a univariate approach known as the Box and Jenkins method to model time series. This approach involves four (04) steps as follows:

- Initial assessment;
- Search for the appropriate representation: identification and estimation of the ARMA processes ;
- Model validation;
- Forecasting.

3.1.1 Initial assessment

Before proceeding with the modeling, it is first necessary to check the stationarity of the series using the temporal graph, the correlograms, as well as the unit root tests (ADF test). In this work, the ADF test will be used to determine the degree of integration of the overdrafts series.

- The graph

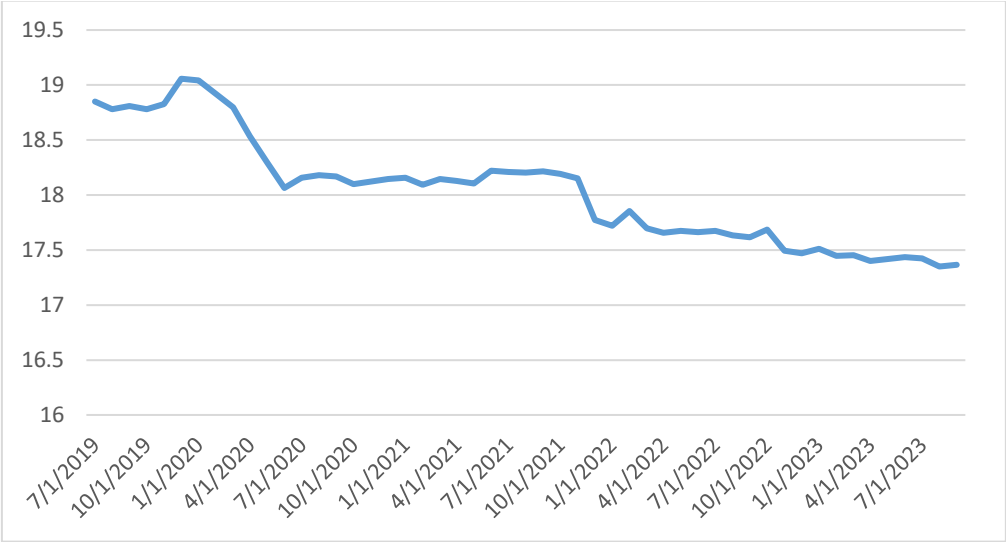
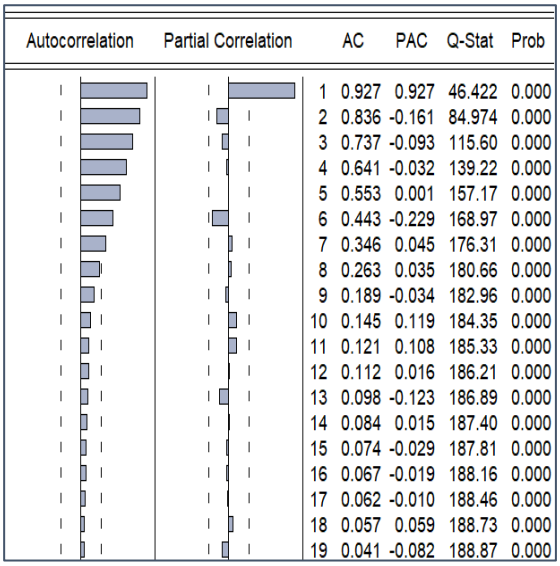


Figure 18: Evolution of log overdrafts *Author's work using QNB's internal data*

The evolution of overdrafts follows a downward trend during the study period. By the looks of its evolution, it seems nonstationary. We will try to confirm this with the correlogram and the Unit Root Test (ADF test).

- The correlogram :

According to examination of the correlogram of the overdrafts series: the simple autocorrelation function (visible on column AC) does not converge quickly to zero. Therefore, the DAV series appears to be non-stationary.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.927	0.927	46.422	0.000
		2	0.836	-0.161	84.974	0.000
		3	0.737	-0.093	115.60	0.000
		4	0.641	-0.032	139.22	0.000
		5	0.553	0.001	157.17	0.000
		6	0.443	-0.229	168.97	0.000
		7	0.346	0.045	176.31	0.000
		8	0.263	0.035	180.66	0.000
		9	0.189	-0.034	182.96	0.000
		10	0.145	0.119	184.35	0.000
		11	0.121	0.108	185.33	0.000
		12	0.112	0.016	186.21	0.000
		13	0.098	-0.123	186.89	0.000
		14	0.084	0.015	187.40	0.000
		15	0.074	-0.029	187.81	0.000
		16	0.067	-0.019	188.16	0.000
		17	0.062	-0.010	188.46	0.000
		18	0.057	0.059	188.73	0.000
		19	0.041	-0.082	188.87	0.000

Figure 19 : Correlogram of Loverdrafts

Author's work using Eviews 10

- Unit root test : To confirm the non-stationarity of the series, we apply the ADF test. Its hypotheses are as follows:

H_0: if the probability > 5%, the series is non-stationary (presence of a unit root) ;

H_1: if the probability < to 5%, the series is stationary (absence of a unit root).

Clearly the probability > 5%, so we accept the null hypothesis: the overdrafts series is not stationary.

The series must be differentiated in order to stationarize it.

Null Hypothesis: LOVERDRAFTS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.139390	0.5118
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

Figure 20: ADF test of Loverdraft

Author's work using Eviews 10

Stationarization : $d\_log\_overdrafts_t = log\_overdrafts_t - log\_overdrafts_{(t-1)}$

To ensure that the series has become stationary after the first difference, it is necessary to go through the same process using the graph, the correlogram and the ADF test.

- Graphic representation :

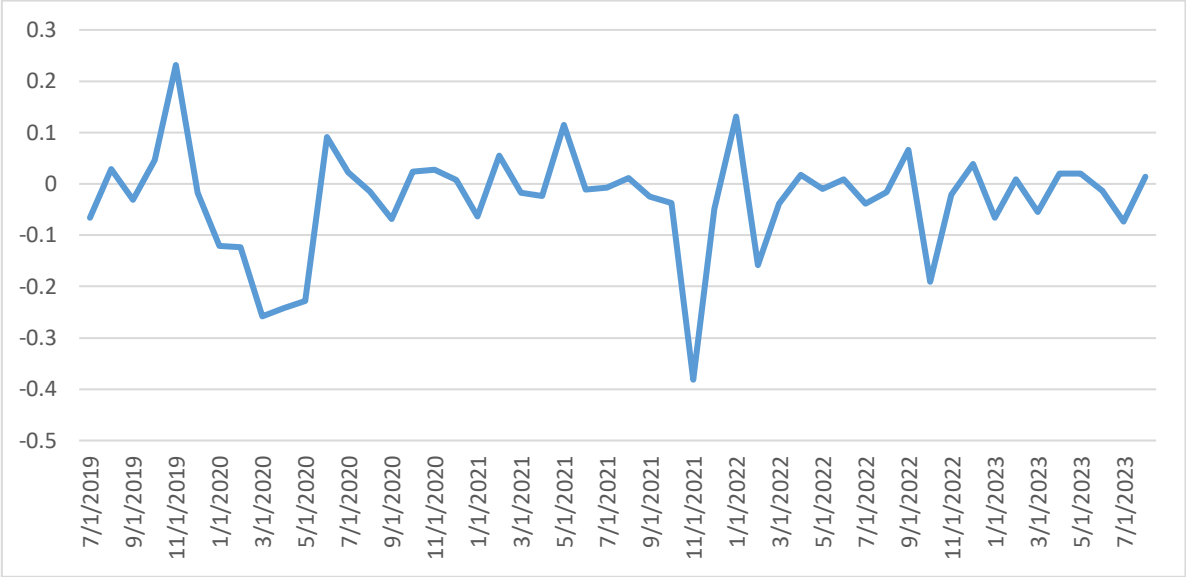


Figure 21 : Evolution of the differenciated series d_log_overdrafts **Author's work using Eviews 10**

The above graph of the differenciated series shows that the trend has been eliminated, the series seems at first glance stationary. This observation must be confirmed by the result of the unit root test.

- Unit Root test :

The probability in the ADF statistical test is < 5%. We accept hypothesis H1: hence, the model is stationary.

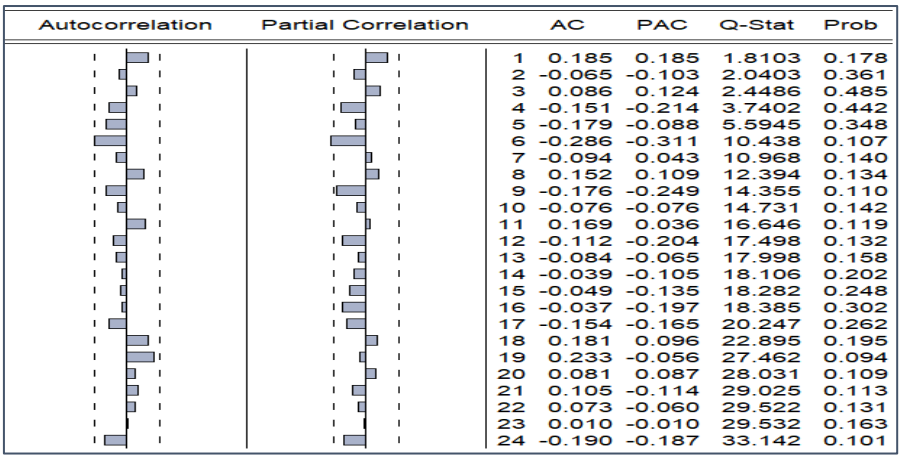
Null Hypothesis: DLOVERDRAFTS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.721395	0.0021
Test critical values:	1% level	-4.161144	
	5% level	-3.506374	
	10% level	-3.183002	

Figure 22 : ADF test of d_log_overdrafts
Author's work using Eviews 10

3.1.2 Identification and estimation of ARMA

The next correlogram allows to get a hint on the nature of the ARMA process that the overdrafts series follows. The identification of the ARMA model (p,q) of the series is determined by observing the correlogram, but the latter can be insufficient sometimes.



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.185	0.185	1.8103	0.178
		2	-0.065	-0.103	2.0403	0.361
		3	0.086	0.124	2.4486	0.485
		4	-0.151	-0.214	3.7402	0.442
		5	-0.179	-0.088	5.5945	0.348
		6	-0.286	-0.311	10.438	0.107
		7	-0.094	0.043	10.968	0.140
		8	0.152	0.109	12.394	0.134
		9	-0.176	-0.249	14.355	0.110
		10	-0.076	-0.076	14.731	0.142
		11	0.169	0.036	16.646	0.119
		12	-0.112	-0.204	17.498	0.132
		13	-0.084	-0.065	17.998	0.158
		14	-0.039	-0.105	18.106	0.202
		15	-0.049	-0.135	18.282	0.248
		16	-0.037	-0.197	18.385	0.302
		17	-0.154	-0.165	20.247	0.262
		18	0.181	0.096	22.895	0.195
		19	0.233	-0.056	27.462	0.094
		20	0.081	0.087	28.031	0.109
		21	0.105	-0.114	29.025	0.113
		22	0.073	-0.060	29.522	0.131
		23	0.010	-0.010	29.532	0.163
		24	-0.190	-0.187	33.142	0.101

Figure 23 : Correlogram of d_log_overdrafts **Author's work using Eviews10**

Which is why it is better in this case to rely on the next step which consists of estimationg different combinations of ARMA processes :

The model we went with is ARMA(3,2). Based on the probabilities (p-values), it appears that the AR(1) and AR(2) coefficients are statistically significant at conventional levels of significance (e.g., 0.05). The AR(3) coefficient is not statistically significant at the 0.05 level but might be considered significant at a higher significance level (e.g., 0,10). The MA(1) and MA(2) coefficients are also significant.

Dependent Variable: DLOVERDRAFTS
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 11/11/23 Time: 21:20
Sample: 2019M08 2023M09
Included observations: 50
Convergence not achieved after 500 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(1)	-1.179719	0.188141	-6.270385	0.0000
AR(2)	-0.507584	0.174688	-2.905658	0.0057
AR(3)	0.260840	0.148570	1.755670	0.0861
MA(1)	1.628895	3.637419	0.447816	0.0065
MA(2)	0.994935	4.400391	0.226102	0.0022
SIGMASQ	0.008282	0.035911	0.230632	0.0087

R-squared	0.195641	Mean dependent var	-0.029682
Adjusted R-squared	0.104236	S.D. dependent var	0.102502
S.E. of regression	0.097013	Akaike info criterion	-1.640463
Sum squared resid	0.414109	Schwarz criterion	-1.411020
Log likelihood	47.01157	Hannan-Quinn criter.	-1.553090
Durbin-Watson stat	1.974319		

Inverted AR Roots	.28	-.73-.62i	-.73+.62i
Inverted MA Roots	-.81-.58i	-.81+.58i	

Figure 24: Estimation of ARMA(3,2)
Author's work using Eviews 10

In conclusion, the ARMA (3,2) model may be considered globally significant and is retained.

3.1.3 Validation of the ARMA model

Validation of the model involves examining the heteroskedasticity of the errors of the process.

This is a statistic test for the overall significance of the ARCH effect. In this output, the F-statistic is very close to zero (7.59E-05), and the associated probability is very high (0.9931). A high p-value suggests that we fail to reject the null hypothesis of no ARCH effect. Which means that the errors of the model are homoskedastic.

Heteroskedasticity Test: ARCH

F-statistic	7.59E-05	Prob. F(1,47)	0.9931
Obs*R-squared	7.91E-05	Prob. Chi-Square(1)	0.9929

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/10/23 Time: 15:30
Sample (adjusted): 2019M09 2023M09
Included observations: 49 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000798	0.000348	2.289570	0.0266
RESID^2(-1)	-0.001272	0.145980	-0.008713	0.9931

R-squared	0.000002	Mean dependent var	0.000797
Adjusted R-squared	-0.021275	S.D. dependent var	0.002287
S.E. of regression	0.002311	Akaike info criterion	-9.262093
Sum squared resid	0.000251	Schwarz criterion	-9.184876
Log likelihood	228.9213	Hannan-Quinn criter.	-9.232797
F-statistic	7.59E-05	Durbin-Watson stat	1.998811
Prob(F-statistic)	0.993085		

Figure 25 : Heteroskedasticity test of ARMA model
Author's work using Eviews 10

3.1.4 ARMA Forecast of overdrafts

Once we have respected all previous B&J methodology modeling steps, it is now time to conduct the overdraft forecasting using the ARMA model**.**

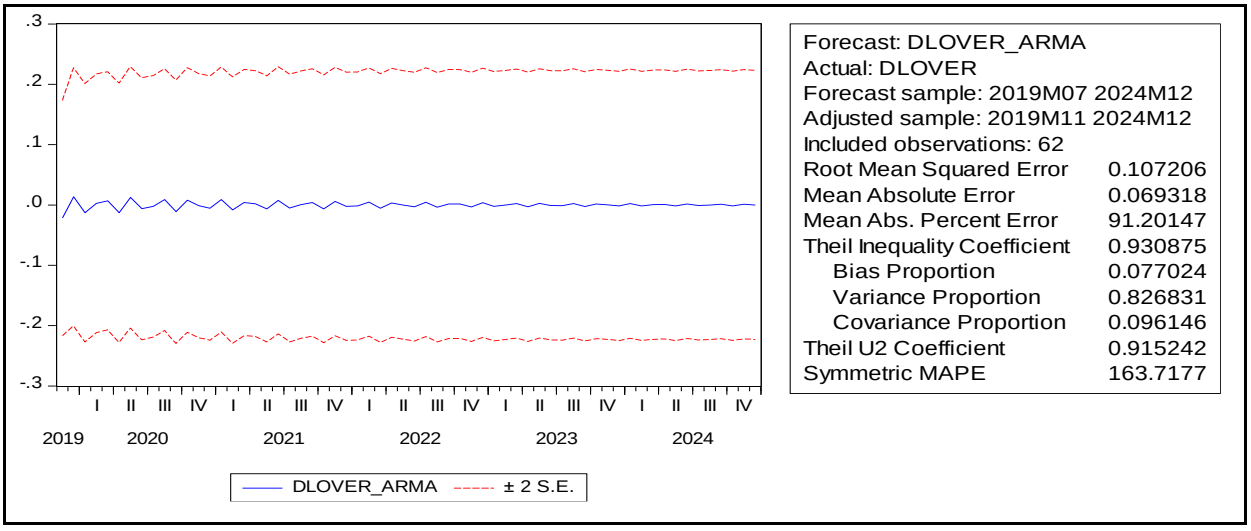


Figure 26 : Overdrafts forecasting using ARMA model *Author's work using Eviews 10*

The blue line in the graph represents the forecast of the series. However, it is not a very good representative of it. It is almost constant, which means that it does not capture any of the variation in the series. Additionally, it leaves out a lot of information.

A better forecast would be one that is more dynamic and that captures more of the variation in the series. Which is why we are going to opt for the ARDL (Auto Regressive Distributed Lag) model instead of Box and Jenkins' ARMA model.

3.1.5 ARDL modeling

The ARDL (AutoRegressive Distributed Lag) method is a time series analysis technique that can be used to examine long-term relationships between different variables.

In order to forecast the overdrafts series through the ARDL model, several steps are required.

- Once the data is prepared, having involved checks for consistency, removal of outliers, and transformation if necessary, it is important to test the integration of the series, typically conducted using the previously used unit root test ADF.
- The next step involves estimating the ARDL model through ordinary least squares (OLS) regression.
- Finally, the fourth step is to perform series forecasts using methods such as ordinary least squares (OLS) or generalized least squares (GLS).

3.1.5.1 ARDL estimation of overdrafts

We will be estimating the following equation (using the other variables we will be studying) :

$$Loverdrafts\ (t) = \alpha + \beta 1\ Loverdrafts\ (t-1) + \beta 2\ Lsavings\ (t) + \beta 3\ LDDs\ (t) + \varepsilon t$$

The results are the following :

Dependent Variable: LOVERDRAFTS
Method: ARDL
Date: 11/10/23 Time: 11:15
Sample (adjusted): 2019M08 2023M09
Included observations: 50 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (4 lags, automatic): LSAVINGS
Fixed regressors: LDDS C
Number of models evalulated: 20
Selected Model: ARDL(1, 0)
Note: final equation sample is larger than selection sample
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOVERDRAFTS(-1)	0.924930	0.095136	9.722176	0.0000
LSAVINGS	-0.159045	0.245125	-0.648832	0.0519
LDDS	4.189778	2.105157	1.990245	0.0525
C	-8.227535	5.898521	-1.394847	0.1698

R-squared	0.959706	Mean dependent var	18.02034
Adjusted R-squared	0.957078	S.D. dependent var	0.488090
S.E. of regression	0.101121	Akaike info criterion	-1.668387
Sum squared resid	0.470367	Schwarz criterion	-1.515426
Log likelihood	45.70969	Hannan-Quinn criter.	-1.610139
F-statistic	365.2029	Durbin-Watson stat	1.619070
Prob(F-statistic)	0.000000		

Figure 27: Estimation of ARDL model
Author's work using Eviews 10

The ARDL estimation appears to be a good fit for the data. The R-squared is high, and the coefficients are all statistically significant. The Durbin-Watson statistic is also within the acceptable range, which suggests that there is no autocorrelation in the residuals.

Overall, the ARDL estimation suggests that LOVERDRAFTS is a persistent series that is negatively related to LSAVINGS and positively related to LDDS. And is reliable for the forecast.

3.1.5.2 ARDL forecast of Overdrafts

The last step is forecasting. The predictive quality of the model should be verified through comparisons between the actual and the forecast data.

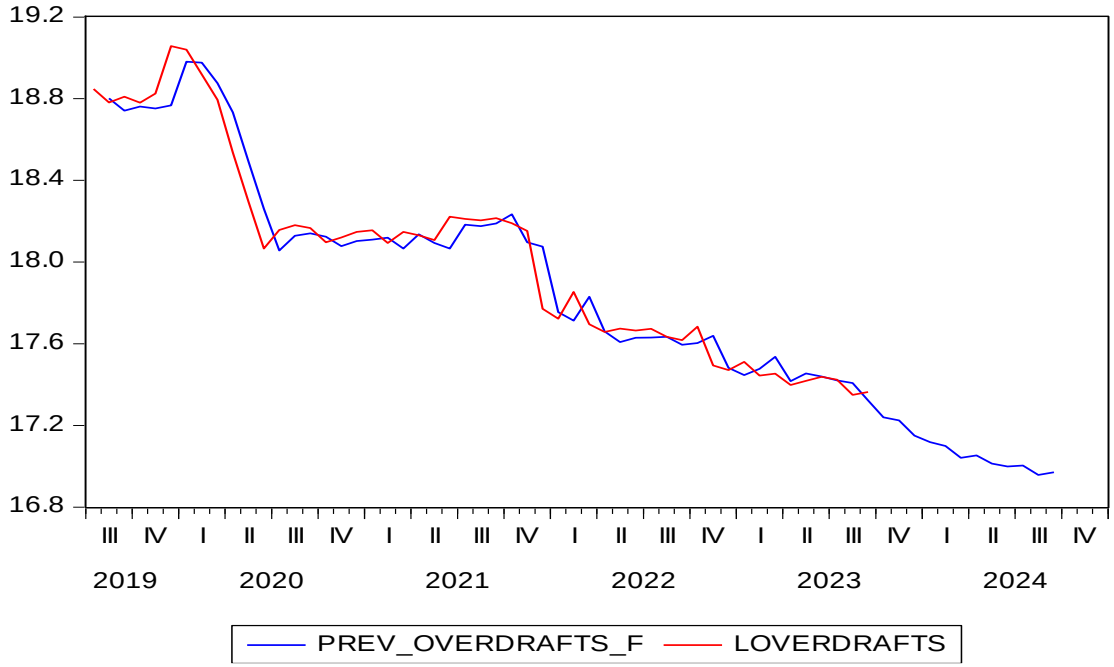


Figure 28 : Overdrafts forecasting using ARDL model *Author's work using Eviews 10*

Based on the graph, it is clear that the ARDL model is reliable and very close to reality. The model's forecast closely tracks the actual overdraft data, suggesting that it is able to capture the underlying trends and dynamics of the series.

One reason why the ARDL model is so reliable is that it is a dynamic model. This means that it takes into account the lagged values of the overdraft series, as well as other relevant variables such as demand deposits and savings. This allows the model to capture the persistent nature of the overdraft series and to make more accurate forecasts.

Another reason why the ARDL model is so reliable is that it is a statistically robust model. The coefficients of the model are all statistically significant, and the model has a high R-squared value. This suggests that the model is well-fitting and that it is able to explain a large proportion of the variation in the overdraft series.

To further check the accuracy and exactitude of the prevision, let us backtest it by comparing it to the observed data :

Table 19 : Forecast disparity of overdrafts

Date	Observed data	Forecasted data	Forecast disparity
31/01/2023	40 258 497	37 747 552	6%
28/02/2023	37 667 563	38 937 694	-3%
31/03/2023	38 004 877	41 305 492	-9%
30/04/2023	35 968 028	36 629 845	-2%
31/05/2023	36 684 752	38 069 102,9	-4%
30/06/2023	37 430 001	37 483 413,8	0%
31/07/2023	36 905 494	36 796 837,9	0%
31/08/2023	34 273 621	36 302 943	-6%
30/09/2023	34 733 328	33 333 527	4%

Author's work using QNB's internal data

The forecast differences do not exceed 10%. Thus, the model is generally acceptable.

3.2 Modeling of QNB's Demand Deposits (DDs)

Customer demand deposits represent an important source of funding highly sought after by banks, as their returns are almost negligible. However, they also constitute a liquidity risk factor since they are not subject to a contractual maturity, and therefore, their withdrawals can occur from one day to the next. Given their crucial importance at the level of the bank's balance sheet, we considered it essential to carry out a statistical treatment of these items in order to be able to predict and integrate their future behavior at the level of liquidity construction of gaps.

To do this, we used ARDL modeling (Box and Jenkins turned out to be non pertinent for demand deposits also).

3.2.1 Initial Assessment

- Graphic representation :

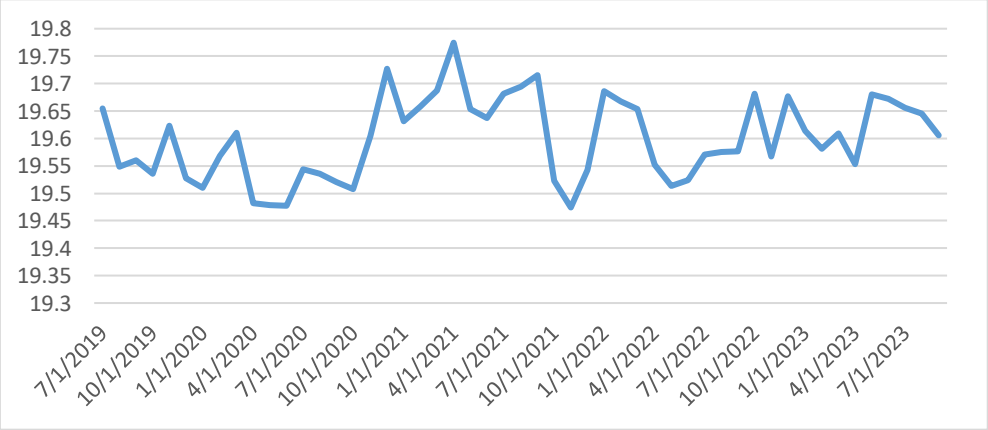
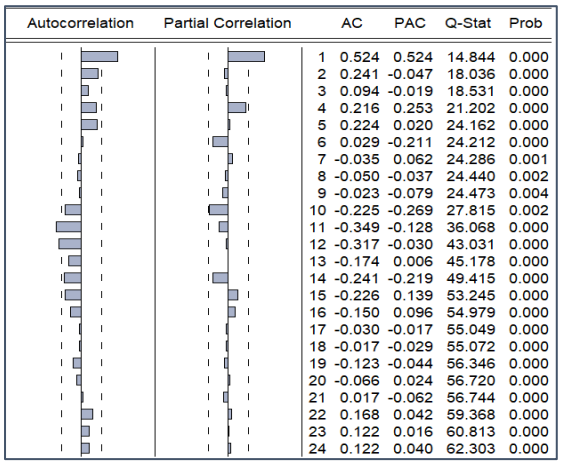


Figure 29: Evolution of log_demand_deposits *Author's work using Eviews 10*

At first glance, the DDs series seems not to follow a trend, which leads us to assume that it may give rise to a stationary series. This has to be confirmed by the correlogram and the ADF test.

- The correlogram :



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.524	0.524	14.844	0.000
		2	0.241	-0.047	18.036	0.000
		3	0.094	-0.019	18.531	0.000
		4	0.216	0.253	21.202	0.000
		5	0.224	0.020	24.162	0.000
		6	0.029	-0.211	24.212	0.000
		7	-0.035	0.062	24.286	0.001
		8	-0.050	-0.037	24.440	0.002
		9	-0.023	-0.079	24.473	0.004
		10	-0.225	-0.269	27.815	0.002
		11	-0.349	-0.128	36.068	0.000
		12	-0.317	-0.030	43.031	0.000
		13	-0.174	0.006	45.178	0.000
		14	-0.241	-0.219	49.415	0.000
		15	-0.226	0.139	53.245	0.000
		16	-0.150	0.096	54.979	0.000
		17	-0.030	-0.017	55.049	0.000
		18	-0.017	-0.029	55.072	0.000
		19	-0.123	-0.044	56.346	0.000
		20	-0.066	0.024	56.720	0.000
		21	0.017	-0.062	56.744	0.000
		22	0.168	0.042	59.368	0.000
		23	0.122	0.016	60.813	0.000
		24	0.122	0.040	62.303	0.000

The correlogram of the demand deposits series shows that the autocorrelation and partial autocorrelation coefficients decline rapidly towards zero as the lag increases. This suggests that the demand deposits series is stationary.

Figure 30 : Correlogram of demand deposits

Author's work using Eviews 10

- Unit Root Test :

Figure 31 : ADF test of demand deposits

Null Hypothesis: LDDS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.190467	0.0090
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

Author's work using Eviews 10

The probability associated to the ADF statistical test equals 0,0090 < 5%, So we accept hypothesis H_1: the model is stationary (absence of a unit root). Which means that the series is integrated at zero-order ($I_{(0)}$).

3.2.2 ARDL estimation of Demand Deposits

The follwing equation is to be estimated :

$$LDDS\ (t) = \alpha + \beta 1\ LDDs\ (t-1) + \beta 2\ Loverdrafts\ (t) + \beta 3\ Lsavings\ (t) + \varepsilon t$$

The results of the estimation are represented in the following figure :

Dependent Variable: LDDS
Method: ARDL
Date: 11/10/23 Time: 12:52
Sample (adjusted): 2019M08 2023M09
Included observations: 50 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (4 lags, automatic): LOVERDRAFTS LSAVINGS

Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(1, 0, 0)
Note: final equation sample is larger than selection sample
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LDDS(-1)	-0.045342	0.178346	-0.254233	0.0084
LOVERDRAFTS	0.007637	0.003467	2.202739	0.0327
LSAVINGS	0.029475	0.007159	4.117293	0.0002
C	2.433203	0.547030	4.448026	0.0001

R-squared	0.234845	Mean dependent var	2.976982
Adjusted R-squared	0.184944	S.D. dependent var	0.006822
S.E. of regression	0.006159	Akaike info criterion	-7.265224
Sum squared resid	0.001745	Schwarz criterion	-7.112262
Log likelihood	185.6306	Hannan-Quinn criter.	-7.206975
F-statistic	4.706182	Durbin-Watson stat	1.976108
Prob(F-statistic)	0.006010		

Figure 32 : ARDL estimation of demand deposits

Author's work using Eviews 10

All of the estimated model coefficients are statistically significant at the 5% level, implying that they have a non-zero effect on LDDS.

The model demonstrates a good fit, with an R-squared value of 0.2348 and an adjusted R-squared value of 0.1849, indicating that the model explains a substantial portion of the variability in LDDS. The Durbin-Watson statistic of 1.9761 suggests that there is no autocorrelation in the residuals, further supporting the model's validity.

In summary, the ARDL estimation provides valuable insights into the dynamics of demand deposits and the factors that influence its behavior. The model's statistical significance, good fit, and consistent interpretation suggest that it is a reliable tool for understanding and forecasting LDDS.

3.2.3 ARDL forecast of Demand Deposits

The forecasting of demand deposits looks as follows :

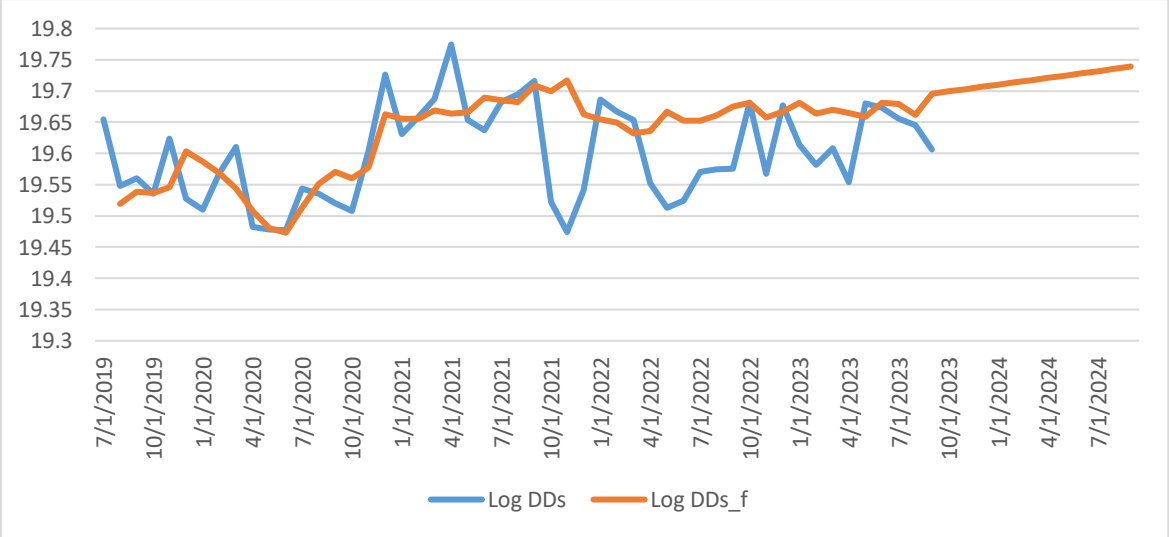


Figure 33 : Demand deposits forecasting using ARDL model *Author's work using Eviews 10*

Overall, the graph suggests that the model is doing a good job of forecasting demand deposits. The forecast closely tracks the actual DDs series, and the ARDL model was able to capture the underlying trends and dynamics of the series.

To further verify this, we will conduct a backtesting on the predictive data.

Table 20 : Forecast disparity of demand deposits

Data	Observed data	Forecasted data	forecast disparity
31/01/2023	329 668 142	352 603 303	-7%
28/02/2023	319 235 445	346 670 563	-9%
31/03/2023	328 093 214	348 645 831	-6%
30/04/2023	310 500 595	346 815 838	-12%
31/05/2023	352 402 821	345 016 317	2%
30/06/2023	349 684 965	352 553 063	-1%
31/07/2023	343 711 651	351 900 768	-2%
31/08/2023	340 376 502	345 993 231	-2%
30/09/2023	327 197 578	357 843 606	-9%

Author's work using QNB's internal data

All forecast differences do not exceed 10% except for one which still is very close to 10% (12%). Hence, we can consider that the forecast is globally acceptable.

3.3 Modeling of QNB's Savings

Although contractually these resources can be subject to restitution at any time, they are statistically more stable than demand deposits. In order to anticipate the future behavior of this balance sheet section by type of counterparty, we have set a sample of 52 mothly observations for the same analysis period.

The same statistical approach (ARDL) is followed in the modeling of the savings series.

3.3.1 Initial Assessment

- Graphic representation :

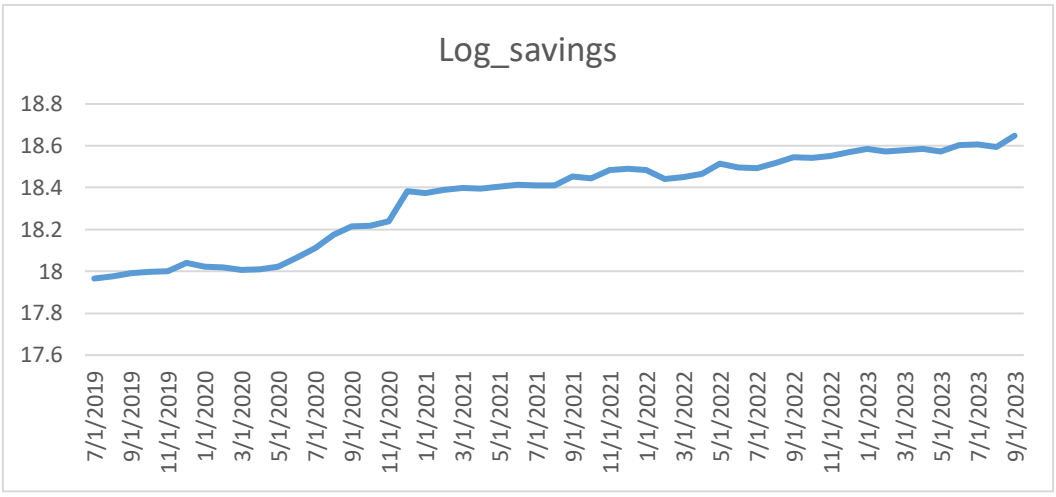
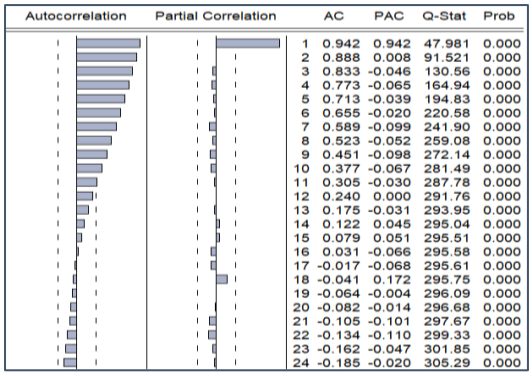


Figure 34 : Evolution of log_savings *Author's work using Eviews 10*

The savings graph shows an upward trend. The latter suggests that the mean of the series is increasing over time, which can mean that the series is not stationary. This is to be confirmed using the correlogram and the unit root test.

- The correlogram :



	AC	PAC	Q-Stat	Prob
1	0.942	0.942	47.981	0.000
2	0.888	0.008	91.521	0.000
3	0.833	-0.046	130.56	0.000
4	0.773	-0.065	164.94	0.000
5	0.713	-0.039	194.83	0.000
6	0.655	-0.020	220.58	0.000
7	0.589	-0.099	241.90	0.000
8	0.523	-0.052	259.08	0.000
9	0.451	-0.098	272.14	0.000
10	0.377	-0.067	281.49	0.000
11	0.305	-0.030	287.78	0.000
12	0.240	0.000	291.76	0.000
13	0.175	-0.031	293.95	0.000
14	0.122	0.045	295.04	0.000
15	0.079	0.051	295.51	0.000
16	0.031	-0.066	295.58	0.000
17	-0.017	-0.068	295.61	0.000
18	-0.041	0.172	295.75	0.000
19	-0.064	-0.004	296.09	0.000
20	-0.082	-0.014	296.68	0.000
21	-0.105	-0.101	297.67	0.000
22	-0.134	-0.110	299.33	0.000
23	-0.162	-0.047	301.85	0.000
24	-0.185	-0.020	305.29	0.000

Figure 35 : Correlogram of savings
Author's work using Eviews 10

The correlogram shows a slow decline in the autocorrelation coefficients as the lag increases. They do not converge quickly to zero. This suggests that the series has long-range memory or dependence, and therefore is not stationary.

- Unit root test :

Null Hypothesis: LSAVINGS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.332425	0.8681
Test critical values:	1% level	-4.152511	
	5% level	-3.502373	
	10% level	-3.180699	

Figure 36: ADF test of savings
Author's work using Eviews 10

This is confirmed by the ADF test : the probability > 5%, so we accept the null hypothesis H0: the savings series is not stationary (existence of a unit root).

To find the degree of integration, we apply the ADF test on the first difference of the series.

Null Hypothesis: D(LSAVINGS) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.693130	0.0000
Test critical values:	1% level	-4.156734	
	5% level	-3.504330	
	10% level	-3.181826	

Fair enough, the series is now stationary (probability < 5%), which leads us to conclude that the savings series is integrated of order 1.

Figure 37 : ADF test of d_lsavings
Author's work using Eviews 10

3.3.2 ARDL estimation of Savings

The follwing equation is to be estimated :

$$Lsavings\ (t) = \alpha + \beta 1\ Lsavings\ (t-1) + \beta 2\ Log\_overdrafts\ (t) + \beta 3\ LDDs\ (t) + \varepsilon t$$

The results of the estimation are represented in the following figure :

Dependent Variable: LSAVINGS
Method: ARDL
Date: 11/10/23 Time: 11:27
Sample (adjusted): 2019M08 2023M09
Included observations: 50 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Schwarz criterion (SIC)
Dynamic regressors (4 lags, automatic): LOVERDRAFTS LDDS
Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(1, 0, 0)
Note: final equation sample is larger than selection sample
White heteroskedasticity-consistent standard errors & covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LSAVINGS(-1)	0.900375	0.044149	20.39416	0.0000
LOVERDRAFTS	-0.038522	0.016650	-2.313668	0.0252
LDDS	0.160075	0.737863	0.216943	0.0292
C	2.059012	1.632552	1.261223	0.2136

R-squared	0.985002	Mean dependent var	18.35971
Adjusted R-squared	0.984024	S.D. dependent var	0.217280
S.E. of regression	0.027464	Akaike info criterion	-4.275277
Sum squared resid	0.034696	Schwarz criterion	-4.122315
Log likelihood	110.8819	Hannan-Quinn criter.	-4.217028
F-statistic	1007.005	Durbin-Watson stat	2.029711
Prob(F-statistic)	0.000000		

Looking at the estimation, the coefficients of all three variables Lsavings(-1), Loverdrafts and LDDs, seem to be statistically significant at the 5% level.

The R-squared: 0.985002 indicates that the model explains a high proportion of the variance in the dependent variable.

Figure 38 : ARDL estimation of savings
Author's work using Eviews 10

Overall, the ARDL estimation results suggest that the model is a good fit for the data and that the lagged LSAVINGS variable, the LOVERDRAFTS variable, and the LDDS variable are all important predictors of current LSAVINGS. It is then safe to carry out the forecast.

3.3.3 ARDL forecast of Savings

The projected outlook for savings is as shown in the graphic representation below :

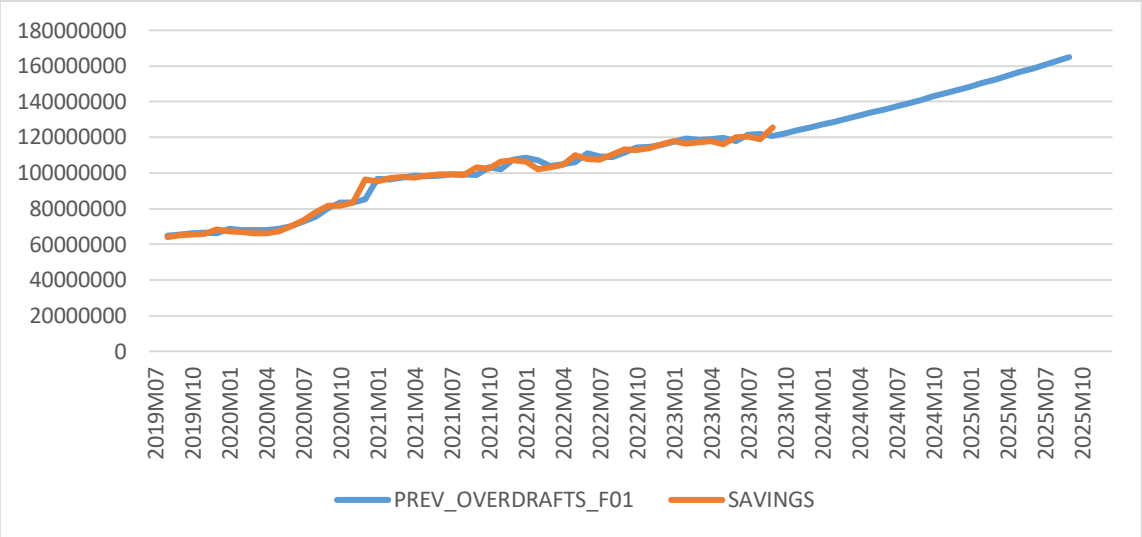


Figure 39 : Forecasting of savings using ARDL model *Author's work using Eviews 10*

The graph shows that the forecasted savings data is very close to the actual one. This is a good indication that the forecasting model is a good fit for the data. It was able to capture the overall trend of the savings data, as well as the short-term fluctuations.

To further demonstrate this, a backtesting is conducted in the following table :

Table 21 : Forecast disparity of savings

Date	Observed data	Forecasted data	Forecast disparity
2023M01	117 863 651	117 386 794,2	0%
2023M02	116 582 675	119 244 557,2	-2%
2023M03	117 303 601	118 585 896,1	-1%
2023M04	117 966 754	118 918 638,4	-1%
2023M05	116 268 543	119 831 445,4	-3%
2023M06	120 007 899	118 055 924,5	2%
2023M07	120 266 630	121 364 638,9	-1%
2023M08	119 048 878	121 937 571,9	-2%
2023M09	125 564 410	120 724 455,3	4%

Author's work using QNB's internal data

All forecast differences do not exceed 10%. The forecast is globally acceptable.

4 Measurement of the bank's exposure to liquidity risk

After having analyzed the different balance sheet items in detail, and modeling the non contractual items of the balance sheet, we will now measure QNB's liquidity exposure as of 12/31/2022 using incremental marginal gaps, whilst taking into account the hypotheses adopted by the bank firstly, then the ones formulated by us as a suggestion.

4.1 Construction of the marginal liquidity gaps using the hypotheses held by QNB

The marginal liquidity gaps, also known as incremental gaps, represent the difference between the inflows and outflows of funds at a given period. This allows for the determination of needs and surplus resources related to each maturity class.

The following table and graph illustrate the main results concerning the construction of QNB's marginal liquidity gaps as of 12/31/2022 using the hypotheses held by the bank (a more detailed version of this table is found in appendix 01).

Table 22 : Marginal liquidity gaps 1

Period	Asset amortizations[9]	Liability amortizations[10]	Marginal liquidity gaps 1
< 3 months	692 206 000	995 590 000	- 303 384 000
[3 - 6 months[	74 296 000	128 645 000	- 54 349 000
[6 months - 1 year[	143 638 000	240 951 000	- 97 313 000
[1 y - 2 years[	114 982 000	87 798 000	27 184 000
[2 y - 5 years[	282 463 000	53 055 000	229 408 000
[5 y - 7 years[	89 464 000	1 073 000	88 391 000
> 7 years	261 955 000	151 892 000	110 063 000

Author's work using QNB's internal data

In order to have a better visualization of the situation, we have translated the figures in the table into a graph, as follows:

[9] Asset amortizations = cash inflows
[10] Liability amortizations = cash outflows

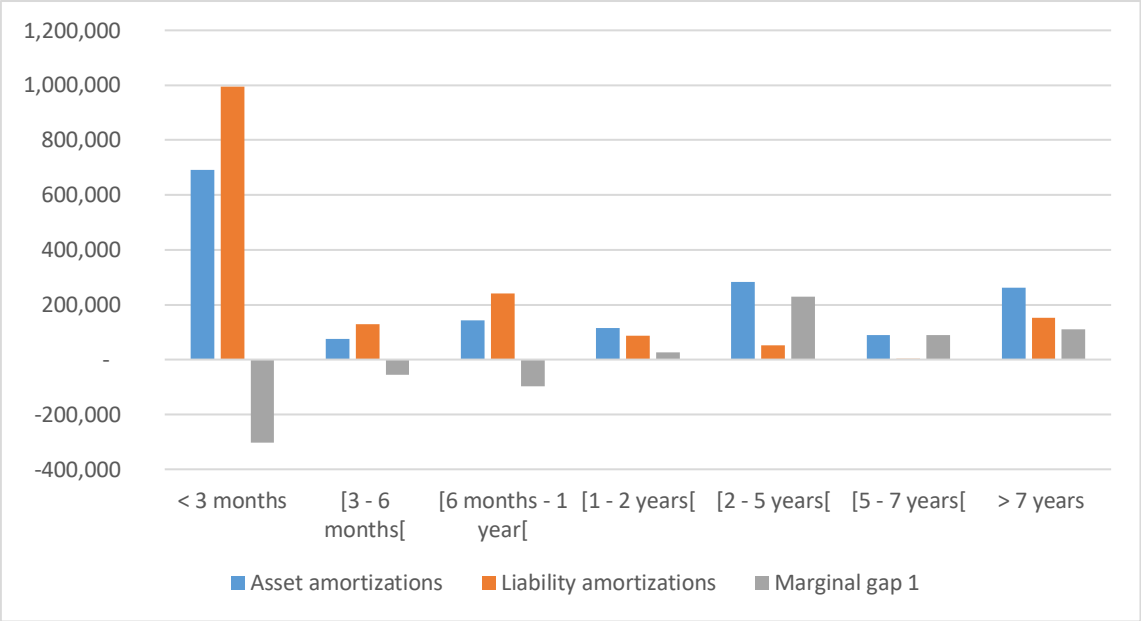


Figure 40 : Marginal liquidity gaps 1 *Author's work using QNB's internal data*

The above chart summarizes the cash inflows and outflows calculated, as well as the anticipated mismatches recorded between these two flows for each time bucket. The graph's pattern allows us to identify two phases of assessing the bank's liquidity situation over the projection horizon:

Phase 1: This phase extends over the first three maturity bands (less than 3 months to 6 months - 1 year) and is characterized by a net outflow of funds. During this period, the total outstanding liabilities maturing exceed those of the assets. This leads us to conclude that the bank is in a situation of liquidity shortage and it clearly undergoes transformation risk. This transformation risk arises from the practice of financing long-term activities with short-term resources.

To further explain, due to a lack of necessary liquidity over a long period and an imbalance between assets and liabilities, the bank is currently unprofitable and is unable to fulfill its obligations. This mismatch can also mainly be attributed to the significant weight of fund outflows in the « Customer deposits and funds » balance sheet item, particularly in Demand Deposits and Savings accounts.

Given this predicament, the bank must implement measures to mitigate this risk and bridge the negative difference between liabilities and assets in order to compensate for the deficit in current assets.

Phase 2: In this phase, involving the last three maturity bands (1 - 2 years and > 7 years), the bank exhibits a surplus liquidity situation as all marginal gaps become positive. This significant mismatch between the cash flows of the two balance sheet items for this period is primarily due to the decrease in maturing funds related to the deposits category.

According to the above results, we can conclude that the hypotheses held by QNB for calculating maturity profiles of certain balance sheet items have specific limitations, particularly in the demand deposits and savings categories, as well as in the overdrafts item on the assets side, seeing as the latter doesn't possess a contractual maturity and can be withdrawn at any minute.

These hypotheses appear to rarely present an honest and transparent image on the bank's true level of exposure to liquidity. Therefore, we will resort to estimates obtained through modeling.

4.2 Construction of the marginal liquidity gaps using the modeling results

The table and graph below illustrate the main results relating to the establishment of QNB's marginal liquidity gaps as of 12/31/2022 using the modeling results (a more detailed version of this table is found in appendix 02). The new hypotheses that we suggest following take into account new productions for the items with the uncertain maturity (overdrafts, demand deposits and savings).

PS. The 52 observations relied upon for the modeling allowed us to forecast a period of 2 years only, which is why we will be focusing merely on the first 4 time buckets (starting from < 3 months till 2 years).

Table 23 : Marginal liquidity gaps 2

Time buckets	Asset amortizations	Liability amortizations	Marginal Gap 2
< 3 months	650 900 509	532 117 663	118 782 846
[3 - 6 months[	78 118 078	125 267 740	- 47 149 662
[6 m - 1 year[	153 052 677	224 310 118	- 71 257 441
[1 y - 2 years[	121 054 320	50 569 346	70 484 974

Author's work using QNB's internal data

These figures are represented by the following histogram:

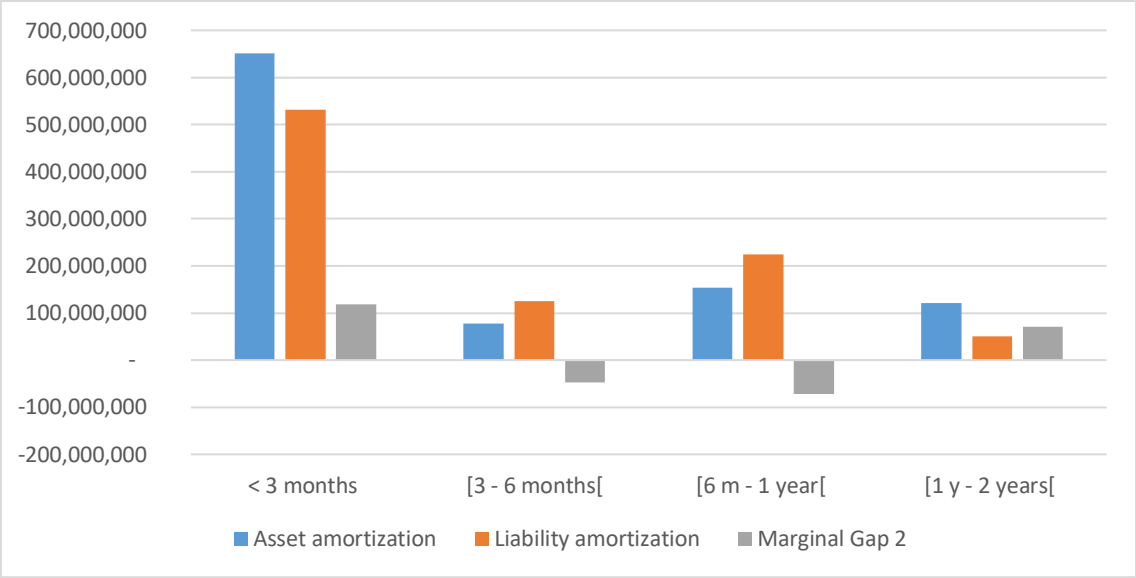


Figure 41 : Marginal liquidity gaps 2 *Author's work using QNB's internal data*

We note from the figure above that there is an improvement in the liquidity situation of the bank during these periods.

The first marginal gap (< 3 months), for instance, is no longer negative. Both of the following gaps (3-6 months & 6m- 1 year) appear to be negative still, but we can definitely notice an enhancementt in the liquidity of QNB. The last maturity band presents a surplus and shows an improvement in its already positive state as well.

We notice that the new hypotheses which rely on modeling and forecasting in the calculation of the new time buckets of overdrafts, demand deposits and savings, all of which have no contractual deadlines, has granted the bank with a certain amount of improvement. In fact, inclusion of forecasts in the development of these time buckets and subsequently, the bank's liquidity gaps, have allowed the bank to have access into more information regarding the behaviour of these series, resulting in a more accurate amortization table for all three variables. Respect of the level of these more realistic amortization rates allowed us to better enhance the position of the bank in terms of liquidity.

To sum it up, from the results obtained above, we can conclude that the use of the estimates obtained through modeling seem to give a more realistic/optimistic result than the one obtained using the hypotheses adopted by the bank.

The difference between the gaps calculated using QNB's hypotheses and those calculated using modeling is presented in the following table :

Table 24:Marginal liquidity gaps 1&2

Time buckets	Marginal Gap 1	Marginal Gap 2	Percentage of improvement
< 3 months	- 303 384 000	118 782 846	139,15%
[3 - 6 months[	- 54 349 000	- 47 149 662	13,25%
[6 m - 1 year[	- 97 313 000	- 71 257 441	26,78%
[1 y - 2 years[	27 184 000	70 484 974	159,29%

Author's work using QNB's internal data

These numbers are further illustrated by the histogram below:

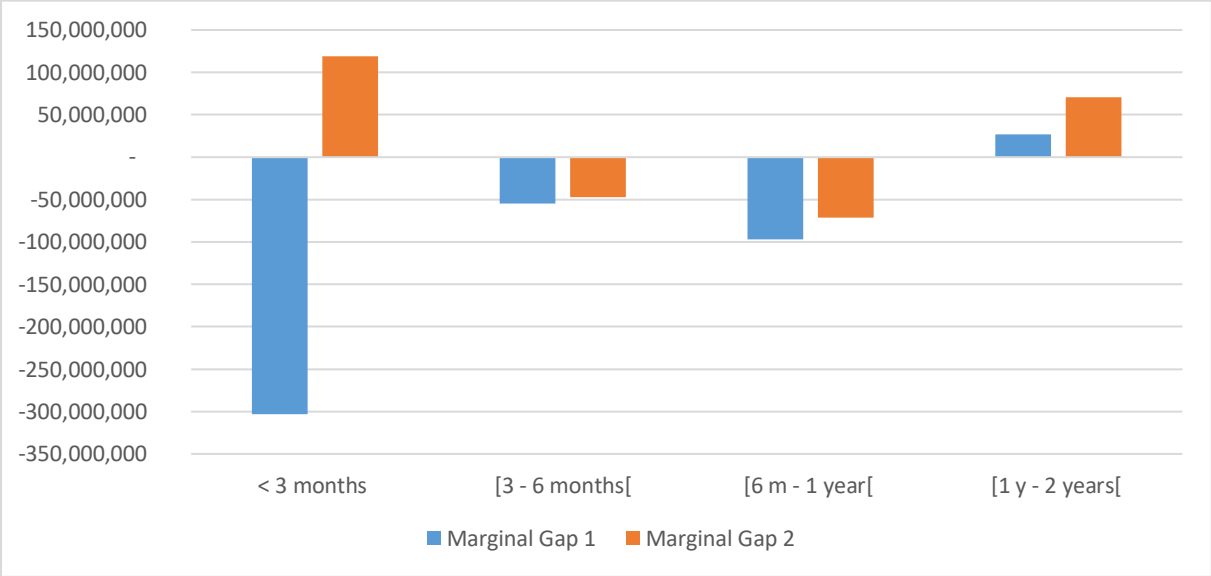


Figure 42: Marginal liquidity gaps 1 & 2 *Author's work using QNB's internal data*

The improvement is more obvious now that the incremental gaps following both hypotheses are presented next to each other, one by one.

- For the time bucket "< 3 months", there is a significant improvement of 139.15% in the Marginal Gap 2 compared to Marginal Gap 1. This indicates that not only has the liquidity position improved, but it has shifted from a negative to a positive value.
- In the "[3 - 6 months[" time bucket, there is a 13.25% improvement. This suggests that while both gaps are negative, the magnitude of the gap has decreased, indicating better liquidity management in this time frame.
- The "[6 m - 1 year[" bucket shows an improvement of 26.78%. Similar to the previous bucket, both gaps are negative, but the improvement suggests a reduction in the liquidity gap.

- Finally, the "[1 y - 2 years[" bucket exhibits a 159.29% improvement, which is the most significant improvement across all time buckets. This dramatic increase is due to Marginal Gap 2 not only covering the entire Marginal Gap 1 but also adding a substantial positive amount to the liquidity position.

Overall, these percentages indicate a marked enhancement in the bank's liquidity position across all time buckets. The improvements are particularly notable thanks to the use of forecasting estimates which allows for better results regarding the bank's liquidity risk exposure. If paired with a focused management of liquidity risks and a strategic well thought approach, the bank is certain to maintain positive liquidity gaps. This shoud align with a prudent financial management strategy and could be reflective of improved cash flows, better asset-liability matching, or both.

Conclusion

Given that the ALM (Asset Liability Management) approach is among the most important methods in the field of financial risk management for banking institutions. Such management is essential in this rapidly transforming environment characterized by the presence of numerous banking risks that can impact the operational continuity of banks and the entire financial system.

Therefore, in this final chapter, we attempted to put into practice some tools of the ALM approach to measure the level of liquidity risk to which QNB is exposed. After presenting the organizational structure and its current situation, we conducted an analysis of the bank's assets and liabilities to establish their maturity profiles. Then, we delved into the modeling of three non contractual items in the balance sheet, namely: the overdrafts, demand deposits and savings series using the ARDL model. This method helped us forecast the outstanding balances of the variables during the years 2022 and 2023.

Subsequently, we proceeded to calculate the bank’s incremental liquidity gaps. This was done by applying two approaches: one following the hypothesis of cessation of activity adopted by QNB and the other by including the future productions of the estimated series using the forecasts generated by the modeling. We compared both results to prove there is an enhancement in the bank’s liquidity situation thanks to the modeling.

General Conclusion

Given the nature of their activities and the environment in which they operate, which is constantly changing and characterized by increased competition and a constantly evolving digital transformation, banks are always exposed to a variety of risks. To this end, effective management of these risks is essential in order to help banking institutions protect themselves against financial difficulties that can jeopardize their operating activities which are based on the transformation of maturities.

The international subprime crisis made it possible to realize the importance of liquidity risk as well as the preponderant role that banking liquidity can play in terms of financial stability of the entire banking system. As a result, the Basel Committee has integrated liquidity risk alongside counterparty risk, market risk and operational risk and has added new prudential standards, namely the short-term liquidity ratio (LCR) and the long-term one (NSFR).

In addition to complying with regulatory standards, banks must have internal tools to prevent and manage such risks. This is the context in which our thesis is framed, which aims to assess the level of exposure of QNB to liquidity risk using the ALM approach, one of the internal risk assessment approaches.

After presenting the different theoretical concepts that frame this research, we tried to highlight the importance of ALM for QNB in order to ensure an adequacy of assets and liabilities. To do this, we chose three balance sheet items whose weights are more or less important at the level of the total balance sheet of the bank, namely : overdrafts on the asset side, demand deposits and savings on the liability side. These balance sheet items have no contractual maturities, which led us to model the series using the Auto-Regressive Distributed Lag model (ARDL) in order to try to predict their evolution in the future.

Subsequently, we were able to deduce the amortizations of these balance sheet elements in the period leading up to 2 years (an equivalent of 4 time buckets) which is the period length of the forecasting data we were able to obtain from the ARDL modeling. These amortizations we got using the forecasting hypotheses (that take into consideration new productions of the items with uncertain maturities) are compared with the amortization hypotheses held by QNB (that are based on cessation-of-activity for all elements, including those with no defined maturity, meaning that non-maturing items will disappear overnight).

General Conclusion

Afterwards, based on the time buckets developed, we calculated the incremental liquidity gaps by applying both of these methods. The objective is to analyze the impact of each of these methods on the liquidity situation of the bank. As per the other contractual balance sheet items, we carried out a detailed analysis, item by item.

Acceptably, the results obtained based on the modeling seem to be more realistic than those obtained with the hypotheses retained by the bank. They reveal an enhancement in the bank's liquidity situation over the observed periods. Notably, the initial marginal gap (less than 3 months) is no longer in the negative territory. Although the gaps for the subsequent periods (3-6 months and 6 months to 1 year) remain negative, a discernible improvement in QNB's liquidity is evident. The final maturity band displays a surplus, indicating further enhancement in its already positive state.

It is noteworthy that the incorporation of new hypotheses, relying on modeling and forecasting in the computation of overdrafts, demand deposits, and savings across various time buckets, has contributed to the observed improvement. The inclusion of forecasts in developing these time buckets, consequently impacting the bank's liquidity gaps, has provided valuable insights into the behavior of these series. This, in turn, has facilitated the creation of a more accurate amortization table for all three variables. Adhering to these more realistic amortization rates has therefore significantly reinforced the bank's liquidity position.

In summary, utilizing estimates obtained through modeling proves more realistic and optimistic compared to the traditionally adopted hypotheses. This approach, which estimates the future evolution of select balance sheet items, avoids the application of the cessation of activity hypothesis to the entire balance sheet. It enables a more objective estimation of liquidity, allowing the bank to prepare a plan for a global alignment between assets and liabilities, with the aim to reduce its level of exposure to liquidity risk.

However, while it is fair to acknowledge the merits of our approach, it is imperative to recognize its inherent limitations. In fact, even with modeling, the prediction of gaps remains subject to uncertainties primarily stemming from potential modeling errors, given that the new production model is merely an approximation of reality. The forecasts, after all, by their nature, are estimated from the historical data of the variables themselves, without taking into account other variables that can be of influence.

In conclusion, the complexity of implementing ALM becomes apparent, necessitating the organization of information, centralization of data, and coordination among various

structures. This complexity underscores the importance of having an efficient and reliable information system to successfully employ ALM as a strategic tool. Moreover, it's crucial to view asset-liability management as an integral part of planning and prospecting. It should therefore be considered a valuable decision-making tool rather than being a standalone decision criterion.

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Appendices

Appendix 1: Detailed Marginal Liquidity Gaps 1

Assets	less than 3 months	3 - 6 months	6 months - 1 year	1 - 2 years
Treasury and cash	57 716 000	0	0	0
Claims on banking and financial institutions	228 382 000	1 125 000	35 057 000	2 417 000
Customer receivables	237 584 000	71 827 000	43 613 000	101 585 000
* Overdrafts (debit current accounts)	38 714 163	0	0	0
* Remaining receivables	198 869 837	71 827 000	43 613 000	101 585 000
Commercial securities portfolio	0	0	5 074 000	0
Investment portfolio	152 850 000	-	56 444 000	5 000 000
Fixed assets	4 328 000	490 000	928 000	1 655 000
Other assets	11 346 000	854 000	2 522 000	4 325 000
Total assets amotizations	692 206 000	74 296 000	143 638 000	114 982 000
Liabilities				
Central bank deposits and funds	67 002 000	0	0	0
Deposits and funds of financial banking institutions	25 452 000	20 000 000	0	0
Customer deposits and funds	820 349 000	89 881 000	189 665 000	50 271 000
* Demand depsosits	347 592 000	0	0	0
* Savings	116 122 000	0	0	0
* Term deposits	356 635 000	89 881 000	189 665 000	50 271 000
Borrowings and special resources	27 428 000	18 764 000	51 286 000	37 527 000
Other liabilities	55 359 000	-	-	-
Total liabilities amortizations	995 590 000	128 645 000	240 951 000	87 798 000
Marginal (Incremental) Gaps	- 303 384 000	- 54 349 000	- 97 313 000	27 184 000
Cumulative marginal gaps	- 303 384 000	- 357 733 000	- 455 046 000	- 427 862 000

Appendices

Appendix 2 : Detailed Marginal Liquidity Gaps 2

Assets	less than 3 months	3 - 6 months	6 months - 1 year	1 - 2 years
Treasury and cash	57 716 000	0	0	0
Claims on banking and financial institutions	228 382 000	1 125 000	35 057 000	2 417 000
Customer receivables	196 278 509	75 649 078	53 027 677	107 657 320
* Overdrafts (debit current accounts)	-2 591 328	3 822 078	9 414 677	6 072 320
* Remaining receivables	198 869 837	71 827 000	43 613 000	101 585 000
Commercial securities portfolio	0	0	5 074 000	0
Investment portfolio	152 850 000	0	56 444 000	5 000 000
Fixed assets	4 328 000	490 000	928 000	1 655 000
Other assets	11 346 000	854 000	2 522 000	4 325 000
Total assets	650 900 509	78 118 078	153 052 677	121 054 320
Liabilities				
Central bank deposits and funds	67 002 000	0	0	0
Deposits and funds of financial banking institutions	25 452 000	20 000 000	0	0
Customer deposits and funds	356 876 663	86 503 740	173 024 118	13 042 346
* Demand deposits	2 705 332	-3 907 232	-9 202 017	-16 067 832
* Savings	-2463669	529972	-7 438 865	-21 160 822
* Term deposits	356 635 000	89 881 000	189 665 000	50 271 000
Borrowings and special resources	27 428 000	18 764 000	51 286 000	37 527 000
Other liabilities	55 359 000	-	-	-
Total liabilities	532 117 663	125 267 740	224 310 118	50 569 346
Marginal (Incremental) Gaps	118 782 846	- 47 149 662	- 71 257 441	70 484 974
Cumulative marginal gaps	118 782 846	71 633 184	375 743	70 860 717

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