

The application of ALM and micro stress test on Algerian banking sector

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Abstract:

This paper examine the liquidity status of single commercial bank named national bank of Algeria, using the impasse method, based on receivables and payables over a five years horizon, then calculated the transformation index and tested the bank's resistance to a short-term liquidity crisis by applying stress test scenarios. The results of analysis liquidity position shows that the bank's balance sheet is structurally liquid. The purpose of our study is to contribute to the improvement of crisis management tools in the line of ALM and stress testing models, based on a descriptive and analytical approach.

Keywords Risks, crisis, banks Stress testing, ALM.

JEL Classification: G0, G170, G210.

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1. Introduction.

During the decade 80 of the twentieth century, the banking environment became very unstable and very vulnerable to the various fluctuations of the financial sphere. Indeed, the deregulation of financial activities was accompanied by an increase in the volatility of financial markets and increased competition between the various institutions. This new situation has contributed to the development of more dynamic methods in the management of banking risks, such as Asset and Liability Management (ALM) and stress testing.

Asset- Liability Management is a set of management methods and tools used to measure and control financial risks. The importance of ALM has increased with the growth of market instability, the emergence of derivative products and the growing complexity of bank balance sheets. Nowadays, ALM has achieved a certain maturity: techniques been standardized, which has allowed a certain amount of software editors to propose solutions to assist managers.

In addition, ALM inexistent in most Algerian Banks and that may be due to the dominance of the other risks not managed by ALM. Therefore, the aim of this study is to demonstrate the importance of the ALM and its Committee in the management of the banking risks in view of his development in the financial risks management systems of the Algerian Banks.

The 2007 - 2009 Financial Crisis has highlighted the importance of Liquidity as a key component in the banking system. It has also underlined the complexities of liquidity risk measurement and the multiple issues that it raises in terms of prudential supervision.

This paper is composed of two parts: one is devoted to definitions, approaches and previous results, and the other to a case study from the *National Bank of Algeria*, which hosted us during our internship. We will examine the bank's liquidity position using asset-liability management and stress-testing techniques and stress test scenarios. Some comments made as the analysis progresses before presenting recommendations that would eventually ensure the improvement and modernization of risk management in this bank through the implementation of ALM.

• Research objective

The main objective of this article is to detail and show the importance and the purposes of asset-liability management and bank stress testing as a means of assessing and managing banking risks, and to understand the global impact of the risk of liquidity on assets and liabilities.

• Research questions

To focus our work, we have posed the following problem:

How the ALM approach and stress testing contributes to the management of liquidity risk in an Algerian bank ?

In order to answer our problem and to provide the most relevant answers, we must answer the following questions:

- What is the ALM? And what is a stress test?
- What is the usefulness of these tools in liquidity risk management?
- How to apply these tools of liquidity in the Algerian banks?

• Research hypotheses

The following hypotheses are visible:

H1: The ALM and stress test are a new tool for covering and managing liquidity risk.

H2: If liquidity risk is not well managed and controlled, it is one of the major risks that could lead to a real crisis.

H3: ALM and Stress testing identify the bank's weaknesses to lower the risk of a liquidity crisis that causes disruptions.

- **Research Methodology**

The research methodology followed throughout this work is the descriptive-analytical method, based on documentary research through the consultation of various books and academic works that address our subject.

- **Literature review**

How much capital and liquidity does a bank need to support its risky activities? During the recent (and still ongoing) financial crisis, answers to this question using standard approaches such as regulatory capital ratios were no longer credible, so ALM and large-scale prudential stress testing became the new tool. Bank balance sheets are notoriously opaque and sensitive to asset substitution (easy swapping of high-risk assets for low-risk ones). Adapting ALM and stress testing, therefore, can bring clarity by openly disclosing details of the results and approaches adopted, thereby helping to regain trust. Once this trust restored, the cost-benefit ratio of stress test disclosure can move away from bank-specific disclosure towards more aggregated information.

Many research studies have been carried out to define a framework for bank stress tests and ALM: (Schuermann, 2013, p. 02) why they are useful and why they have become such a popular tool for the regulatory community during the recent financial crisis; how stress tests are carried out (design and execution); and finally, once the results of stress tests are in hand, how they should be disclosed, and whether they should be different in times of crisis and in “normal” times.

(sahin, Jakob , & Ekaterina , 2020, p. 03), studied the effects of the announcement and disclosure of the clarification, methodology and results of the US bank stress tests on bank share prices, credit risk and systematic risk. Find evidence that stress tests moved stock and credit markets after stress test results disclosed. And also found that banks' systematic risk, as measured by betas, declined in almost every year after stress test results were released. Suggest that stress tests affect systemic risk. Giovanni Petrella, Andrea Resti (2013), examine the 2011 European crisis simulation exercise to determine whether and how it affected bank share prices... The analysis of events shows that the results of the test deemed relevant by investors. (Petrella & Andra , 2013, p. 02). The market did not just look at the detailed historical data published after the tests. But it also attached considerable importance to the variables measuring each bank's vulnerability to the simulated downturn scenario. These include proxies for liquidity risk and model risk. Information on sovereign debt holdings, while affecting market reaction on a uni-variate basis, is not statistically significant in a multi-variate framework. They also note that the market is not in a position to anticipate test results, which is consistent with the idea of greater opacity on the part of banks prior to the disclosure of ALM stress test results. Overall, the analysis shows that ALM and stress tests produce valuable information for market participants and can play a role in mitigating bank opacity.

In general, most previous studies carried out in the context of developed countries, and have demonstrated the role and usefulness of ALM and stress tests as tools for steering, diagnosing and preventing systemic financial crises.

(BOUCHETARA Mehdi, 2017) Thesis for the doctorate in economic and financial sciences LMD, Financial stability and banking crises stress tests banking in Algeria, Abou Belkaid University, Telemcen, 2016/2017. The aim of his thesis is to contribute to the improvement of crisis management tools along the lines of stress test models, based on an analytical approach and enriching, from various angles, previous work based mainly on Top-Down and Bottom-up stress test models.

Previous studies indicate that credit concentration, and more specifically loan concentration, are the main banking risks, and that public banks are the most vulnerable. Most banks hold sufficient liquidity buffers to withstand a major liquidity shock, and interest rate and exchange rate shocks have a limited impact on the banking sector.

2. Asset and liability management (ALM).

The financial concepts applied in asset-liability management only became widespread in the United States in the 1980s, with the appearance of new risk management products and the development of new market activities. Thus, ALM appeared within the cash management units of banks in order to identify and fill cash gaps, which created refinancing risks and resulted in liquidity and interest rate risks. Then, in the mid-1980s, European banks began to align themselves with the management techniques of their counterparts across the Atlantic. This is how asset-liability management came to be used in Europe.

Joël BESSIS defines it as the set of management techniques and tools that enable the measurement and control of financial risks. (Joel, 1995, p. 165)

According to *the decree of the economy and finance of February 11, 1993*, the Asset-Liability Management is a global and coordinated method allowing a company, and in particular a bank, to manage the composition and the adequacy of all its assets and liabilities and its off-balance sheet.

The objective of this method is to optimize the return on equity while preserving an acceptable level of interest rate, exchange rate and liquidity risk and ensuring an allocation of equity capital in such a way as to adapt the volume and structure of uses and resources and activities to market developments and to the financial and regulatory environment in particular to prudential ratios.

It ensures the balance of the cash flow at the current date, to determine the future financing policy according to the degree of risk aversion and finally to protect against a possible reduction of the margins or the value of the institution according to the evolution of the risk factors.

2.1. The ALM approach.

Four steps make up this process: (Coussergues, Gautier Bourdeaux, & Thomas Péran, 2017, p. 204)

a. Identification and measurement of risks

The bank's exposure to various risks measured by analysing its interest rate and foreign exchange liquidity positions. This measurement applied to a specific time horizon that covers at least three to six months but can extend to one year.

b. Interest rate and exchange rate forecasts

To this end, various assumptions made concerning future interest rate and exchange rate trends. These assumptions may reflect either the most widely held opinions of the bank's economic forecasters and economists, or they may envisage very unfavourable developments in order to test the bank's fragility (stress testing).

c. Simulations

In order to carry out the simulations, the forecast interest margin must calculate according to the different hypotheses envisaged, and in the case of the most adverse scenario, the estimated amount of losses is compared with the bank's equity capital. In this way, the governing body can judge whether the amount of risk assumed is acceptable in the light of the preferences expressed by the shareholders.

d. The decisions

It is important to choose from among the various simulations not only the most realistic one, but also the one that will generate the highest profitability for a given level of risk and the one that is most in line with the bank's strategic options in terms of business lines, products and size. Moreover, in order for decisions followed through, balance sheet flexibility is necessary.

2.2. The impact of Asset – Liability management.

(Chaabouni, 2011, p. 7) In terms of organization, it is necessary to ensure that the organization of the institution's asset-liability management meets the principles set out above, in particular ensuring that appropriate committees exist and that senior management participates in these committees, that

an interest rate risk management strategy exists within the institution and that it is updated, and also defining a clearly defined risk limit procedure for returning to these limits if they are exceeded. As well as the independence of ALM managers from the department that manages the institution's cash flow and the reliability of the tools that measure interest rate risk (transparency of the calculations made, audit trail, etc.)

In terms of indicators, a certain number of indicators, often already used by many establishments, now imposed by the new regulations. The board tables used in ALM directed towards the direction and function as a monitoring and piloting tool for the balance. The supervisory authorities should update on a regular basis on the level of rate risk assumed by financial institutions, and all internal reporting components should be accessible for this purpose.

Regarding financial communication, the third Basel pillar, which outlines the market discipline and financial communication that banks subject to regulation must adhere to, primarily affects Asset-Liability management at the level of bank communication about interest rate risk management. Furthermore, a number of banks have included a section detailing their risk management procedures in their annual report. This includes information on the financial risks managed by the ALM as well as the operation of the Asset- Liability cells.

3. Stress testing.

The subprime crisis in the United States since July 2007 has caused a crisis of confidence in the banking sector and consequently a liquidity crisis. This financial crisis sounded the alarm by reminding us that the liquidity risk is not negligible and requires greater attention.

In order to avoid that the same scenario of the crises of the 80's be repeated, a new method of systematic and regular evaluation of the risks threatening the banks and being able to affect the banking system was set up, this method called "stress test" in English, and "test de résistance bancaire" in French.

(Marot, 2004, p. 56)The Basel II reform not only requires banks to report regularly on risk monitoring and performance, but also, via pillar 2, stress scenarios designed to verify that capital is sufficient to withstand a possible deterioration following a change in economic conditions.

Some central banks, including the United states U.S. Federal Reserve in the U.S. and the European Central Bank (ECB) in the Eurozone, have decided to stress test financial institutions to assess their ability to withstand shocks. (J & Cornand , 2013, p. 26).The United States, after the shock of the Lehmann Brothers bankruptcy in September 2008, a large-scale stress test conducted and made public in May 2009 in the United States. This first test was carried out on the 19 largest banks, 9 of which appeared to be sufficiently capitalized, and for the 10 others, the authorities required them to recapitalize up to 75 billion dollars for all of them.

In 2013, the FED* is testing US banks, of which it conducted a new stress test on the 18 largest US banks. The U.S. (Stress testing banks systems : concepts and practice overview of financial sector issues and analysis workshop, 2008, p. 16) central bank chose extreme conditions to better test its banks (12% unemployment rate, 50% drop in stocks and 5% decline in GDP). As a result of this test, it had therefore out of the 18 banks tested only one failed; the other banks obtained a capital adequacy ratio well above 5%.

In Europe, a stress test was conducted in Europe in 2010 to address concerns about the Greek sovereign debt crisis and the health of the banking system. It studied the resilience of 91 major European banks to two negative scenarios: one corresponding to a deterioration of the economy for two consecutive years, and the other including a shock to a sovereign debt. Four French banks were

* FED: The Federal Reserve System is the U.S central bank, created by the Federal Reserve Act of 1913 to establish a monetary system.

tested: BNP Paribas, Crédit Agricole, BPCE** and Société Générale. The results published in July 2010 and were positive.

In July 2010, several banks that had passed the tests then ran into serious difficulties, notably the Irish banks, which had to be recapitalized in a hurry by the government, causing the Irish public deficit to rise from 14% of GDP in 2009 to 32% in 2010 and leading to a rebound of the sovereign debt crisis in the Euro zone.

In 2011, a new round of bank stress tests under the supervision of the new European Banking Authority (EBA) tightened the conditions; the test was based on more pessimistic assumptions about the economic situation.

In 2011 and 2013, major European financial institutions were retested with better results on average, including Spanish and Greek banks.

As part of the preparation for the implementation of the European Banking Union, the ECB conducted between March and October 2014 an asset quality review as well as a stress test of some of the 128 largest banks that will come under its direct supervision from November 4, 2014.

In 2018, the EBA conducted a stress test on 48 banks in the European Union, including six French banks (BNP Paribas, Crédit Mutuel, BPCE, Crédit Agricole, and BPSG). The test showed that the strength of European banks' balance sheets has improved due to the obligations to increase capital.

In Algeria, (*Annuel report* , 2016, p. 72) the Bank of Algeria has developed since 2012, an integrated stress test model adapted to the national context. This solution continued during 2015 and the first tests of the model were conducted after their validation at the end of 2015.

Since 2016, the BA on a regular basis both has carried out stress test exercises individually and at the Algerian banking system level.

The provisions of *the regulation N°11-04 of May 24 of the Bank of Algeria*, relating to the identification, measurement, management and control of liquidity risk emphasize the importance of the implementation of liquidity crisis simulations through robust scenarios as well as the implementation of efficient emergency plans in the event of the occurrence of these scenarios.

3.1. The objectives of stress tests (CEBS, 2010, p. 19)

- Identify the impact of a shock on a portfolio, a company or the banking system as a whole;
- Determine the risk profile of a company, verify existing limits, and evaluate business risks;
- Evaluate the ability of the bank's equity to absorb potentially large losses and identify changes the bank can make to reduce its risk and conserve its equity;
- Identify vulnerabilities in ordinary times and provide elements for dealing with them;
- Communicate with managers but also with regulators.

3.2. Stress testing methodology.

The process followed for the implementation of a liquidity risk stress test consists of four steps. (*Guide* , 2017, p. 03) *The first step inputs, banks and financial institutions are required to transmit regularly to the central bank, data relating to their activities in the framework of control and supervision. To load these data, it is necessary to import the files sent by the banks and insert them in the appropriate format in the corresponding Excel sheet in the FPM* application.*

(Arslaner, 2017, p. 10) *The data used by the application retraces a time horizon equivalent to 12 periods whose frequency is either daily, weekly, monthly, quarterly, semi-annual or annual. These imported data include the following information (the historical balance sheet, Historical income statement, historical prudential statements concerning the solvency ratio, the liquidity ratio...). The second step, mapping the input data to the application. The financial statements (balance sheet and*

** BPCE group: (For Banque Populaire Caisse d'épargne) is a major french banking group formed by the 2009 merger for two major retail banking group (Groupe caisses d'épargne & Groupe banque populaire).

* FPM: The Financial projection Model is an Excel based system of equations that establishes the link between the various variables of a bank's balance sheet, income statement, and cash flow and risk management indicators.

income statement) and the prudential declaration as presented by the banks are different from the form in which they are presented on the FPM application. Hence, the need to go through a "Mapping" stage to match the data provided by the banks with the application, in order to be able to use them and make the necessary proposals to move on to the next stage which is the projection.

Then the third step, data projection. Stress tests used to test the resilience of banks and financial institutions subject to shocks they may face in the future. This requires a projection of data into the future over a time horizon to create a set of forecasted results. Once the projection is completed, a projected balance sheet and income statement obtained, as well as projected CAMELS indicators, on which tests applied to evaluate the bank's resistance when the shock occurs.

Finally, The last step calibration of the projection. In some cases, the projection provides implausible data that follows the historical trend of the data provided but that never realized in the future.

There are other cases where banks provide us with information about future actions that may cause a considerable change after the projection has taken place. It is in these situations that projection calibration comes into play to correct the resulting data in order to provide maximum credibility for our Back-Testing study.

4. Liquidity risk management using ALM and bank stress testing (Case National Bank of Algeria).

Using asset liability management strategies and stress tests, we will examine the liquidity status of the National Bank of Algeria. As the research moves further, a few observations will be made before offering suggestions that would ultimately guarantee the modernization and enhancement of risk management in this bank via the application of ALM.

First, we will attempt to develop the maturity profile and deduce the amortization schedule of uses and resources. This requires the adoption of assumptions concerning the maturities of certain balance sheet items. Then, and from these two tables, we will determine the main indicators of transformation, namely: the liquidity gaps which measures the foreseeable mismatches between all the uses and resources at different future dates, and the liquidity index which measures the degree of mismatch between the maturities of the liabilities and those of the assets and, then we will examine the resistance of the bank to a short-term liquidity crisis by creating stress test scenarios.

4.1. Profile Maturity Model.

The maturity profile is a chart, which classifies assets and liabilities according to their remaining term and therefore represents the amortization of assets and liabilities. (Darmon, 1995, p. 113)

Table 1. Asset maturity profile of National Bank of Algeria (Unit: KDA)

Asset	Cash, BA, CCP, Treasury	Title available for sale	Loans and receivables from FIs	Assets held to maturity	Credits granted	Intermediate assets	Illiquid assets	Total
- 3 month	112 869 644	15 755 144	-	-	9 369 331	20 287 014	-	158 281 132
3-6 month	-	42 761 000	-	-	10 064 795	-	-	52 825 795
6-12 month	-	16 389 385	234 736 786	-	33 820 009	3 536 144	-	288 482 323
12-18 month	-	53 394 580	20 000 000	-	8 919 782	-	-	82 314 363
18-24 month	-	7 750 000	-	-	8 919 782	-	-	16 669 782
24-30 month	-	17 000 000	-	-	14 402 186	-	-	31 402 186
30-36 month	-	10 808 886	-	-	14 402 186	-	-	25 211 072
36-48 month	-	56 924 994	-	-	48 414 607	-	-	105 339 602
48-60 month	-	18 365 964	-	-	161 326 383	-	-	179 692 347
+ 60 month	136 000 000	35 994 476	105 850	244 667 016	1 317 425 138	69 454 074	66 480 776	1 870 127 330
Total asset	248 869 644	275 144 429	254 842 636	244 667 016	1 627 064 200	93 277 232	66 480 776	2 810 345 933

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

Table 2. National bank of Algeria, Maturity profile of liabilities (Unit: KDA)

Liabilities	BA Refinancing	Debts IF	Deposits and volatile savings	TD*s and cash vouchers	Intermediate liabilities	Equity capital	Total
- 3 month	-	1 293 551	41 663 920	43 205 422	21 025 612	-	107 188 505
3-6 month	-	696 528	54 093 199	43 094 355	21 025 612	-	118 909 693
6-12 month	-	28 657 123	57 258 766	53 584 285	50 388 086	-	189 888 260
12-18 month	-		53 860 210	45 381 842	-	-	99 242 052
18-24 month	-	28 657 123	82 861 861	20 327 694	-	-	131 846 678
24-30 month	-		82 861 861	37 758 110	-	-	120 619 971
30-36 month	-		82 861 861	92 155 141	-	-	175 017 002
36-48 month	-		-	19 899 717	-	-	19 899 717
48-60 month	-	76 732 167	-	128 937 025	47 281 423	-	252 950 615
+ 60 month	-		831 234 548	79 844 785	94 525 543	589 178 564	1 594 783 440
Total Liabilities	-	136 036 491	1 286 696 227	564 188 376	234 246 275	589 178 564	2 810 345 933

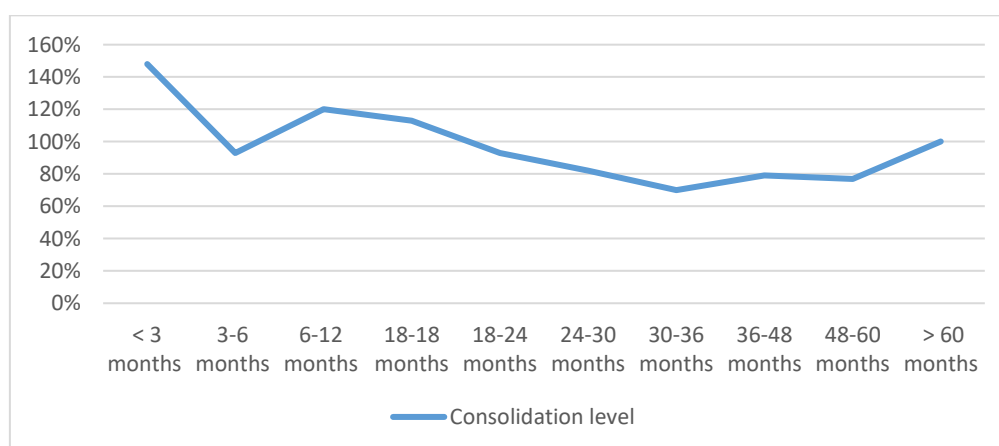
Source: Elaborated by us from internal documents provided by the national bank's Financial Markets Department, 2021.

A consolidated balance sheet is one in which there is a "relatively good" match between the timing of uses and resources. If there is no matching, the extent of the mismatch characterizes the degree of consolidation of the balance sheet.

Table 3. Level of consolidation of the national bank of Algeria balance sheet

Maturity classes	<3 month	3-6 month	6-12 month	12-18 month	18-24 month	24-30 month	30-36 month	36-48 month	48-60 month	> 60 month
Level of consolidation	148%	93%	120%	113%	93%	82%	70%	79%	77 %	100%

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

Figure 1. National bank of Algeria, Level of consolidation for the period 2021 to 2026

Source: Elaborated by us from internal documents provided by the national bank of Algeria Financial Markets Department, 2021.

* TD: Term deposit: is a fixed -term investment that includes the deposit of money into an account at a financial institution.

4.2. Amortization profile:

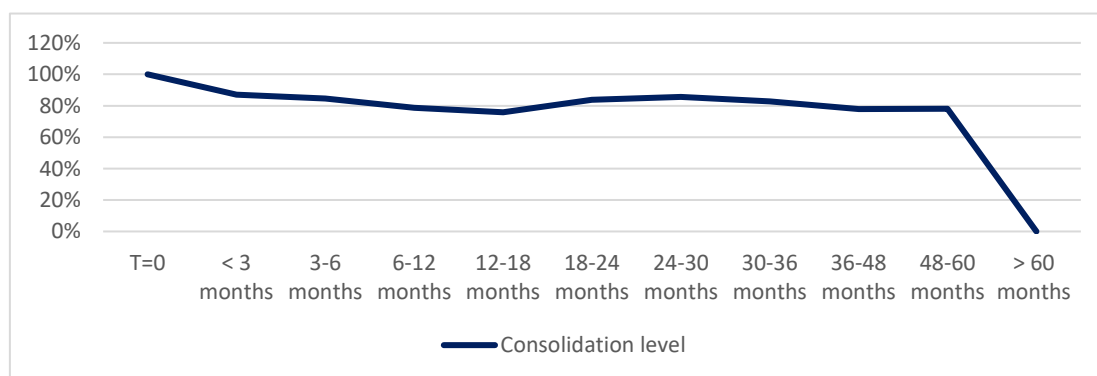
From the maturity profile, it is possible to draw up the amortization table of the Bank's uses and resources.

**Table 4. National bank of Algeria, Depreciation profile of assets and liabilities
(In thousands of DA).**

Maturity classes	Fallen Assets	Fallen Liabilities	Level of consolidation
T=0	2 810 345 933	2 810 345 933	100%
<3 month	2 652 064 801	2 703 157 428	87.02%
3-6 month	2 599 239 006	2 584 247 735	84.6%
6 -12 month	2 310 756 683	2 394 359 475	78.64%
12 -18 month	2 228 442 320	2 295 117 424	75.75%
18 -24 month	2 211 772 538	2 163 270 746	83.79%
24 -30 month	2 180 370 351	2 042 650 775	85.68%
30 - 36 month	2 155 159 279	1 867 633 773	82.7%
36 -48 month	2 049 819 677	1 847 734 055	77.82%
048 -60 month	1 870 127 330	1 594 783 440	77.98%
> 60 month	-	-	0%

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

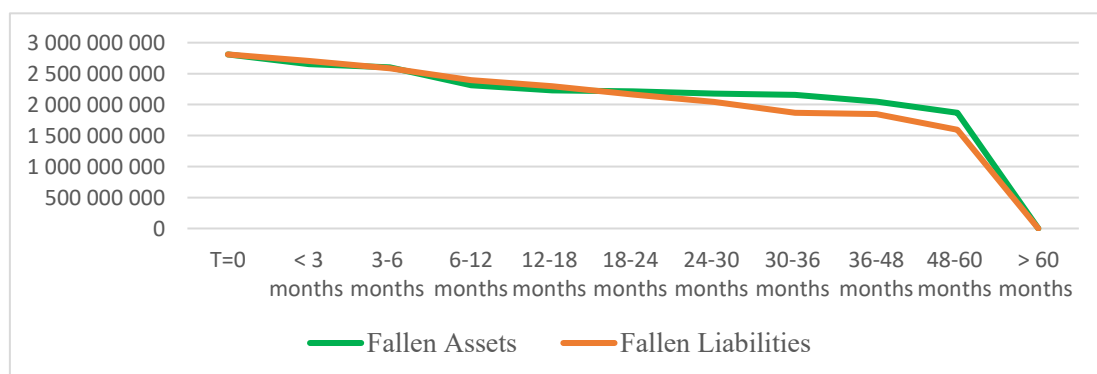
Figure 2. National bank of Algeria, Evolution of the consolidation level



Source: Elaborated by us from internal documents provided by the national bank of Algeria Financial Markets Department, 2021.

From this graph, we can see that the Bank's balance sheet perfectly consolidated and it manages its cash flow well.

Figure 3. National bank of Algeria, Flow of assets and liabilities



Source: Elaborated by us from internal documents provided by the national bank of Algeria Financial Markets Department, 2021.

We can see from this graph that the Bank's balance sheet is well consolidated, with assets and liabilities amortized at the same rate. We can say that the balance sheet of the national bank of Algeria balanced in liquidity.

From the 6th period onwards, the bank's balance sheet has become under-consolidated; the uses amortized more slowly than the resources. The bank must therefore provide new financing to make up the difference between assets and liabilities.

The elaboration of the maturity profile and the calculation of the asset and liability schedules allow us to calculate the flow and stock impasses and the liquidity index.

4.3. Liquidity gaps.

Liquidity gaps calculated in terms of *flows* or *stocks* and make it possible to determine the banks forecasted liquidity needs.

a. Flow liquidity gaps:

"The difference between asset flows and liability flows. It is therefore the difference between cash inflows and outflows during that period.

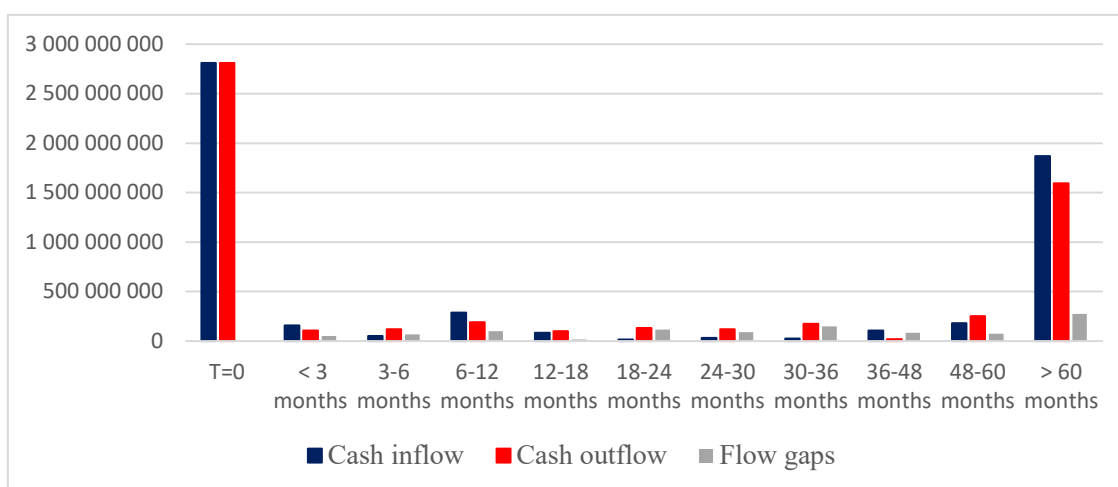
$$\text{Flow gaps} = \text{Cash inflow} - \text{Cash outflow}$$

The flow impasses determine the new requirements at each future date. BNA flow gaps shown in the table and graph below:

Table 5. National bank of Algeria, Liquidity impasses in flows (unit: KDA).

Maturity	Cash inflow	Cash outflow	Flow gaps
t=0	2 810 345 933,00	2 810 345 933,00	0,00
< 3 month	158 281 132,38	107 188 505,08	51 092 627,30
3 - 6 month	52 825 794,75	118 909 692,96	- 66 083 898,22
6-12 month	288 482 323,20	189 888 259,62	98 594 063,58
12 -18 month	82 314 362,68	99 242 051,51	- 16 927 688,83
18 -24 month	16 669 782,38	131 846 677,94	- 115 176 895,56
24 - 30 month	31 402 186,35	120 619 970,94	- 89 217 784,60
30- 36 month	25 211 072,35	175 017 002,41	- 149 805 930,06
36 - 48 month	105 339 601,83	19 899 717,38	85 439 884,45
48-60 month	179 692 346,81	252 950 615,00	- 73 258 268,19
> 60 month	1 870 127 330,29	1 594 783 440,17	275 343 890,12
Total	2 810 345 933	2 810 345 933	- 0,00

Source: Elaborated by us from internal documents provided by the national bank of Algeria Financial Markets Department, 2021.

Figure 4. National bank of Algeria, Liquidity gaps in flows

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

The table above shows that the first period characterized by a significant inflow of funds, which translates into a positive flow impasse and corresponds to the fall in liquid funds (cash in hand and in Central Bank accounts).

The positive impasses also obtained for the classes: 6-12 months, 36-48 months, and more than 60 months result in net inflows of funds that are mainly due to the repayment of loans and receivables on customers as well as the inflows of funds following the repayment of assets available for sale and intermediate assets.

For the third, fifth, 6th, 7th, 8th and 10th periods, we note that liabilities amortized more rapidly than assets, which gives us negative cash flow impasses representing a net cash outflow. This is mainly due to the lapsing of customer deposits and bills rediscounted at the central bank.

Thus, the maximum amount that the Bank will have to face is 73 258 268.19 KDA and which corresponds to the last class of maturity 48- 60.

b. Stock liquidity gaps:

Stock gaps are the differences between outstanding liabilities and assets at a given date. They determine the total accumulated liquidity requirement at a given date.

Calculate the stock gap as follows:

$$\text{Stock gaps} = \text{Liabilities outstanding} - \text{Assets outstanding}$$

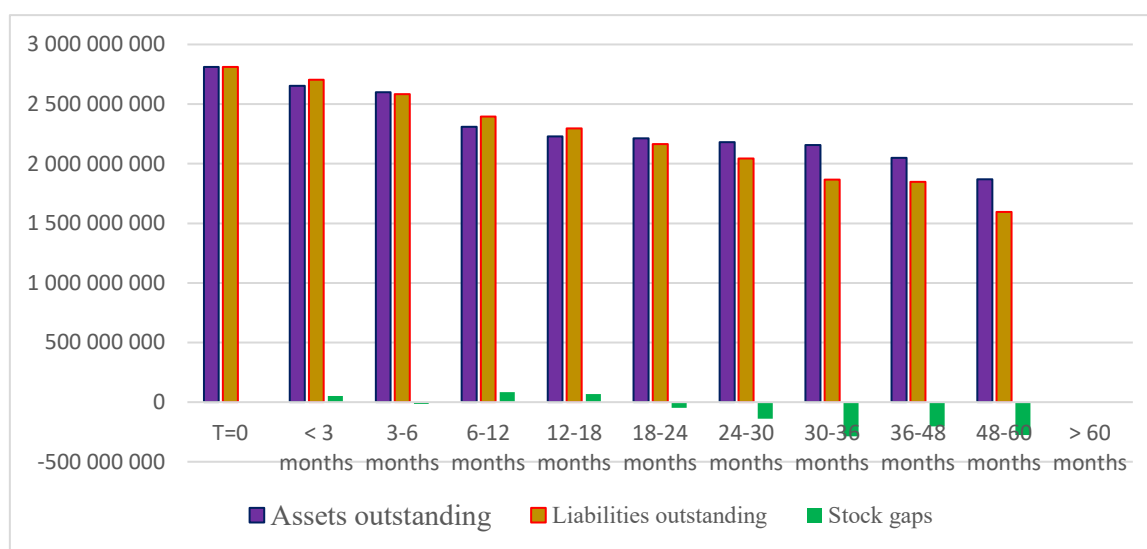
Table.6. Stock liquidity gaps of the national bank of Algeria (unit: KDA)

Maturity	Assets outstanding	Liabilities outstanding	Stock gaps	Level of consolidation
t=0	2 810 345 933,00	2 810 345 933,00	-0	100%
< 3 month	2 652 064 800,62	2 703 157 427,93	51 092 627,30	101,93%
3 - 6 month	2 599 239 005,88	2 584 247 734,96	- 14 991 270,91	99,42%
6-12 month	2 310 756 682,68	2 394 359 475,35	83 602 792,67	103,62%
12 -18 month	2 228 442 320,00	2 295 117 423,84	66 675 103,84	102,99%
18 -24 month	2 211 772 537,62	2 163 270 745,90	- 48 501 791,72	97,81%
24 - 30 month	2 180 370 351,27	2 042 650 774,96	- 137 719 576,32	93,68%
30- 36 month	2 155 159 278,93	1 867 633 772,55	- 287 525 506,38	86,66%

36 - 48 month	2 049 819 677,10	1 847 734 055,17	-	202 085 621,93	90,14%
48-60 month	1 870 127 330,29	1 594 783 440,17	-	275 343 890,12	85,28%
> 60 month	0	0		0	

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

Figure 5. Stock liquidity gaps of the National bank of Algeria.



Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

From the previous table and graph, we can see that the bank does not have any financing needs for the second, 3rd and 4th periods; on the contrary, it must find investments for these surpluses. In this case, the balance sheet favourably exposed to rising interest rates. Client rates on new operations will rise while the cost of resources is already fixed.

For the other periods, we record negative gaps, which correspond to a need for financing over these periods to fill the gap with existing assets. In this case, the balance sheet unfavourably exposed to a rise in interest rates because the future financing required will be more expensive, while the return on existing assets is already fixed.

The first and last gaps are of course zero, as the balance sheet must always be in liquidity.

After calculating the liquidity impasses, we will measure the consequences of a rate increase of, for example, 0.1%, 0.2%, 0.3%, 0.5% on the bank's profitability by evaluating the results of this increase for each impasse, by calculating the variation in the interest margin for each period according to the following formula:

$$\Delta \text{ Marge} = \text{Stock gaps} \times \Delta \text{ Rate} \times \text{Duration}$$

Table 7. The impact of a 0.1%, 0.2%, 0.3%, 0.5% increase in interest rates on the national bank of Algeria profitability (unit: KDA)

Maturity	Stock gaps	Duration	$\Delta \text{ Marge}$ 0,10%	$\Delta \text{ Marge}$ 0,30%	$\Delta \text{ Marge}$ 0,50%
t=0	-0				
3 month	51 092 627	0,125	6 387	19 160	31 933

3-6 month	-14 991 271	0,375	- 5 622	- 16 865	- 28 109
6 -12 month	83 602 793	0,75	62 702	188 106	313 510
12 -18 month	66 675 104	1,25	83 344	250 032	416 719
18 -24 month	-48 501 792	1,75	-84 878	- 254 634	- 424 391
24 -30 month	-137 719 576	2,25	- 309 869	- 929 607	- 1 549 345
30 - 36 month	-287 525 506	2,75	- 790 695	- 2 372 085	- 3 953 476
36 -48 month	-202 085 622	3,5	- 707 300	- 2 121 899	- 3 536 498
48 -60 month	-275 343 890	4,5	- 1 239 048	- 3 717 143	- 6 195 238
60 month to 120 month	0	7,5			
Total			-2 984 979	- 8 954 936	- 14 924 893

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

The cumulative result for a margin of 0.1% is a loss of 2 984 979 KDA. In addition, symmetrically, an increase in rates of 0.1% will result in a loss of 2 984 979 KDA. As well as in 0.3% a loss of 8 954 936 KDA, and finally for 0.5% is 14 924 893 KDA.

4.4. The liquidity index.

The objective of the liquidity index, also called the transformation index, is to ensure sound liquidity management for one year by encouraging banks to finance themselves with stable resources.

$$\text{The transformation index} = \frac{\sum \text{Weighted liability}}{\sum \text{Weighted assets}}$$

Table 8. The transformation index of the national bank of Algeria (unit: KDA)

Maturity	Assets	Liabilities	weighting	Weighted liabilities	Weighted assets
t=0	-	-	-	-	-
< 3 month	158 281 132	107 188 505	0.13	20 576 547	13 934 506
3 - 6 month	52 825 795	118 909 693	0.38	20 073 802	45 185 683
6-12 month	288 482 323	189 888 260	0.75	216 361 742	142 416 195
12 -18 month	82 314 363	99 242 052	1.25	102 892 953	124 052 564
18 -24 month	16 669 782	131 846 678	1.75	29 172 119	230 731 687
24 - 30 month	31 402 186	120 619 971	2.25	70 654 919	271 394 935
30- 36 month	25 211 072	175 017 002	2.75	69 330 449	481 296 757
36 - 48 month	105 339 602	19 899 717	3.5	368 688 606	69 649 011
48-60 month	179 692 347	252 950 615	4.5	808 615 561	1 138 277 767
> 60 month	1 870 127 330	1 594 783 440	7.5	14 025 954 977	11 960 875 801
Total	2 810 345 933	2 810 345 933		15 732 321 675	14 477 814 906

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

4.5. Liquidity Stress test.

In order to test the bank's level of resistance to a short-term liquidity crisis, three stress test scenarios be considered. Indeed, we will assume, for each scenario, the occurrence of a stressful event, and then we will assess their impact on the bank's liquidity.

The first scenario characterized by a high volatility of demand deposits. It assumed that 15% of the sight deposits be withdrawn in 3 months following a crisis of confidence on the solvency of the institution that is materialized by a massive withdrawal of funds from the customers.

The following table shows the effect of the first scenario on liquidity gaps:

Table 9. National bank of Algeria, Flows gaps with the scenario A and B hypothesis (in KDA)

Flow gaps at. 3 months	51 092 627,30	
Scenarios	Scenario A	scenario B
proportion in DD requirements over 3 months	15%	50%
DD requirements in MDA 3 months	193 004 434	643 348 114
proportion Non-performing loans 3 months	20%	40%
Non-performing receivables 3 months	1 873 866	3 747 732
New gaps at 3 months	- 102 121 753	- 554 339 299

Source: Elaborated by us from internal documents provided by the National Bank of Algeria Financial Markets Department, 2021.

Analysing the results of scenario, A, the bank impacted by the massive withdrawal of DD*s over the 3-month horizon due to the significant effect of the shock on the bank's liquidity.

Nevertheless, test B based on an extreme scenario that characterized by a higher volatility of demand deposits. That is, a massive withdrawal of 50% of the demand deposits that occurs in 3 months.

5. Results and discussion.

Our work been articulated in order to demonstrate the contribution of ALM and stress test methods in the optimization of the risk-return ratio of the national bank of Algeria.

Analyze the national bank of Algeria liquidity, we find that the bank's balance sheet is under liquid. Indeed, the liquidity gaps in stock are globally negative, i.e. the assets are amortizing more slowly than the liabilities, except for the 2nd, 4th and 5th period. The bank must necessarily seek new financing to close the gap, to avoid exposure to the risk of unavailability of financing.

- The bank's liquidity index, which is less than 1, confirms this under-liquidity position.
- The ratio of coverage of loans by deposits is greater than 100% ($1,627,064,200 / 1,286,696,227 = 126.45\%$), which means that the bank is profitable (it should be close to 100%) deposits are largely covered by loans. This ratio measures the bank's liquidity, since it links liquidity management to banking performance.
- The results of the stress test showed us that the bank is facing a liquidity crisis. Beyond that, it is impossible to honor its commitments to its customers, especially in a situation where

* DD: Demand deposit: is a bank account from which deposited funds can be withdrawn at any time, without advance notice.

50% of the sight deposits of these customers are withdrawn, due to the absence of a perfect match between its uses and its resources. However, the individual DDs are more stable than those of companies are, so it is preferable to adjust these proportions by conducting a campaign to attract individual DDs, especially savings deposits, by offering a more attractive rate. On the other hand, one must take into account the volatility of the DD and the risk that it represents for the bank, it is then necessary to keep a certain proportion between demand deposit and TD/Bon's of cash, which can constitute a safety cushion.

- The analysis of the GAPS and the bank interest margin confirms this result. In the event of a positive interest rate gap, the bank favourably exposed to a possible rise in interest rates and unfavourably exposed to a fall in rates. In the case of a negative interest rate gap, the bank favourably exposed to a possible fall in interest rates and unfavourably exposed to a rise in interest rates. It concluded that the bank's balance sheet unfavourably exposed to a rise in interest rates.

6. Conclusion.

In the face of various disruptions, banks are increasingly threatened by a variety of risks affecting their activities. They are forced to find solutions to manage these risks and ensure that their management methods are robust in times of crisis. It is in this context of risk management and prevention against violent disruptions that ALM and stress testing were born.

To comply with prudential standards in the field of risk management, the Basel II Committee has put in place measures based on control, market discipline, bank liquidity and prudential ratios, as well as new risk management tools developed both internally and externally, such as ALM and stress tests, which confirms our first Hypothesis

A banking stress test is an exercise in simulating extreme but plausible economic and financial conditions, in order to study the consequences for banks and measure their ability to withstand such situations, which confirms our first Hypothesis.

To answer the second and third hypotheses, we analyzed the methods used within the ALM department of the national bank of Algeria, and concluded that optimization is based on prudent management of liquidity risk, while monitoring profitability and steering margins. The bank must necessarily seek new financing to fill the gap, so as not to expose itself to the risk of unavailable financing, which confirms our second and the third hypothesis confirmed by the results obtained.

Recommendation

In order to better manage the liquidity risk and strengthen its resistance it is recommended to the national bank of Algeria to have a real strategic dimension within the bank and to create an ALM department in charge of measuring and evaluating the banking risks. This department also ensures the control of the respect of the limits of outstanding amounts fixed by counterparty and by product within the framework of the financial activities of the bank. In addition, it would be in charge of:

1. Collect and process the data necessary for risk measurement;
2. Determinate the rules of ALM policy and limits of financial risks as well as the hedging policy that must be put in place;
3. Elaborate different dashboards that include the most relevant management indicators (VAR*, NPV**, sensitivity, ratios...);
4. Have a more efficient ALM software to help managers in their analysis and strategic decision making in terms of measurement and evaluation of major banking risks. Thus,

* VAR: Value at Risk is a statistical measure of the riskiness of financial or portfolios of assets.

** NPV: Net Present Value formula used in investment banking and accounting to determine if an investment project or business will be profitable in the long run.

- the bank is called to develop its information system and have new and more efficient information systems;
5. Apply crisis simulation scenarios. This will enable managers to identify, measure and hedge liquidity risk in order to control it as effectively as possible;
 6. Adopt new policies to manage liquidity risk, such as hedging liquidity gaps through forward borrowing, for example, which eliminates liquidity risk, or voluntarily leaving gaps open according to rate assumptions, which amounts to taking a calculated risk;
 7. Develop a reporting system for a better flow of information between the different bank departments;
 8. Train the staff, as the success of this type of management requires a strong involvement of senior management.

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