A LINEAR PROGRAMMING MODEL FOR ASSESSING ASSET-LIABILITY MANAGEMENT IN NIGERIA DEPOSIT MONEY BANKS

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Abstract
The uncertainty underlying banks multiple objective has prompted banks to seek greater efficiency in the management of their balance sheet. The goal of this present article is to demonstrate the application of goal programming as a means of evaluating assets liability management using a financial statement of three banks in Nigeria from the year 2018 to 2022 with the aid of Lingo software. The first hypothetical scenario represented by bank one shows a strongest financial position as a result of it strong capital accumulation and it ability to optimize it balance sheet. While the second hypothetical scenario represented by bank two revealed as the most balanced performance financial institutions with minimal deviation from its objectives. However, third hypothetical scenario represented by bank three have the largest deviations indicating a weaker financial stability has been reflected in all the finding of the objectives. Nevertheless, the findings implied that effective asset maximization alone is not sufficient enough to achieve optimal financial performance This proposed model would help banks to develop a mathematical model that will examine their balance sheet strengths and weaknesses and likewise identify potential improvement when designing strategies to achieve optimum balance sheet management.

Keyword: Asset-liability management, shareholder fund and linear programming

1.0 Introduction

Efficient allocation of funds in the banking industry is continuously growing strategic significance. This shows that it is imperative for financial managers to comprehend the dynamism of balance sheet management in order to take investment and financial decisions. The balance sheet is predominantly used to gain understanding and insight into a company's financial health because it discloses the company's assets, liabilities, profits and shareholder equity and also provided a complete perspective on the overall financial position precisely what is owned to what is owed. Previous authors like (AlArjani & Alam, 2021; Chen, et al., 2017; Halim, et al., 2015) etc have considered bank balance sheet management in India, Malaysia and Saudi Arabia etc using diffirent techniques. However, studies are scanty in Nigeria using goal programming to evaluate banks balance sheet management.

Understanding the process of managing the items of the balance sheet is essential in order to design strategies and policies when allocating bank resources under different constraints and regulations. Intently, the conventional management of bank balance sheets has been an asset-driven because banks prefer to minimized risk-weighted assets (RWAs) or maximized return on assets (Choudhry, M. 2018; Lubinska, 2020). This approach cannot perfectly meet the need of twenty-first-century banking due to the financial crises of 2007 and likewise, there is an increase in the internationalization of financial markets which has translated to competition in the national and international financial markets. Therefore, banks realized that it is essential to the assets and liabilities simultaneous in order to minimize risk exposure and maximize shareholder's wealth

In addition, banks perform their financial intermediation role with different customers who have varying deposits, borrowing and exposure characteristics. These exposures may to some extent offset each other but may not match absolutely in terms of currency, timing and amount etc. thereby causing variation in the bank balance sheet structure (AlArjani & Alam, 2021). As a result of this, what should be the structure and variations of items in the balance sheet that will enhance the ability of the bank to achieve an optimal balance sheet has always been a puzzle. Authors like Lubinska, (2020), Choudhry, (2017). Jahandideh, et al., (1999) affirmed that for banks to fulfill their financial intermediation role and achieve optimal balance sheets, there is a need to have a proper mixture of assets and liabilities in the balance sheets that can meet up with the regulatory liquidity required, adequate capital, efficient risk management, maximization shareholders wealth etc.

This shows that balance sheet management is multiple objectives with different levels of priorities that must be achieved by the banks Choudhry (2018); Jahandideh, et al., (1999). The study of (AlArjani & Alam, 2021) Iranian banks postulated that for the bank in Iran to achieve an optimal balance sheet there is a need to reduce some of the items in asset class such as cash and bonds in order to achieve an optimum level and likewise increase Qard al-Hasan and decrease other deposits in the liability class to achieve optimal allocation. Furthermore, Tanwar, et al., (2020) affirmed that achieving an optimal balance sheet will aid planning, budgeting, forecasting, and profitability of Allahabad bank. To achieve this, banks normally have an asset-liability management committee or treasury with the mandate of monitoring items in the balance sheet to ensure flows of revenue and comply with laws and regulations that will improve return on risk-taking and likewise mitigate against credit risk, interest rate risk, etc that might affect the value of items in the balance sheet (Brick, et al., 2012; Chen, et al., 2017; Tanwar, et al., 2020).

Previous authors have used different methods in optimizing balance sheet such as (Novickyte, & Petraityte, 2014) used relative index and time series components; (Gülpınar & Pachamanova, 2013). used a robust optimization approach; (Lubinska, 2020) used optimization techniques algorithms based on Lagrange multipliers methods Tanwar, et al., (2020) used goal programming; Alhumaidah, (2015) used mean-variance-liquidation and sensitivity analysis, Arewa, et al., (2013) used goal programming, Bao, et al., (2014) used multiple objective programming and Pareto surface. In Nigeria's context, banks face different constraints and regulatory requirements from the Central bank of Nigeria. This study will use goal programming because of its ability to solve a large-scale multi-criteria decision-making problem to determine the optimum allocation of assets, liability, profits, shareholders' funds, retain earnings and optimum management items giving priorities and identified what has been under or over

achieved in the balance sheet unlike stochastic and dynamic optimization model that requires extensive assumption on probability distribution. The outcome of this will be able to answer critical questions that arise" What should be the structure and variations of items in the balance sheet that will allow banks to achieve optimal balance sheet in a highly regulated environment? The other parts of this paper are divided into literature review, methodology, and data, interpretation of results, conclusion, and recommendations.

2.0 Literature Review

The idea of maximization and minimization of items in the balance sheets of a financial institution is not a new phenomenon. Different authors have used several approached to understand how banks can achieve optimum balance sheets. However, works of literature continue to integrate many factors into the study such regulatory requirement, constraints and various risks. Tanwar, et al., (2020) used goal programming to examine the balance sheet of Indian banks. They postulated that the application of goal programming had helped to achieve an optimal balance sheet and enhanced the bank's decision-making process in the areas of planning, budgeting, forecasting, and profitability of Allahabad bank. However, it was observed that in a ranking of goals, the model couldn't make a provision for the slightest trade-off in ranking which might be possible in the cause of banking operation. Abdollahi, (2020) investigated how Iranian banking industry can achieve asset-liability management using goal programming. His study revealed that managers should modify the portfolio of an asset in order to minimize risk. The study recommended that Mellat bank of Iran should reduce the amount of its cash and bonds in the asset class to achieve an optimum level and likewise increase Qard al-Hasan and decrease other deposits in the liability class to achieve optimal allocation. Conversely, a major defect in the findings of this study was that it could not accurately establish the basic relationship among assets, profit, and loss accounts.

Furthermore, Lubinska (2020) examined asset-liability management optimization using optimization techniques algorithms based on Lagrange multipliers methods. The finding revealed that the optimization model enhanced interest rate risk and liquidity risk management as well as internal risk metrics in all situations applied. They further revealed that application this model decreases the interest rate risk sensitivity. One of the major defects of this study is the use of internal short-term liquidity metrics as a constraint function and also regulatory short-term, liquidity metric liquidity coverage rate has not been included in the model Chen, et al., (2017). considered the optimization of the financial management of the bank using a goal programming model. The results of this study show that all goals were achievable. The result indicated that PBBANK is stable. The study suggested that there can still be an improvement on the balance sheet of the bank Azizi & Neisy (2017) proposed mathematic modeling and optimization of bank assets and liability using a fractional goal programming approach. The finding shows that in the current year the assets in low-productive sectors have been assigned the highest level of capital, particularly the facilities given which are very important while the short-term fundraising in the bank has been increasing and the bank has to try to make its customers satisfied regarding the long-term deposits. Halim, et al., (2015) used a goal programming model to study Maybank financial statement management. The outcome of the study revealed that the bank achieved all the goals set. However, there are rooms for improvement on profitability, equity wealth, earning and the proportion of the values of the items in the financial statement. Bao, et al., (2014) used multiple objective goal programming and Pareto surface to examined integrated risk in

commercial banking financial statements. The findings revealed that to reduce bank exposure to risk, the percentage of their reserve should be increase in order to mitigate against risk exposure and likewise personal loan should be minimized and give more corporate loans and recombinant bonds. This study only considered bank interest-earning assets and interest-bearing liabilities.

In addition, Gülpınar & Pachamanova (2013) examined a robust optimization approach to asset-liability management considering time-varying investment opportunities. The outcome of the study revealed the advantage of robust formulation over the stochastic programming asset-liability management formulation because the size of stochastic programming formulation grows exponentially along with the assets, scenarios and periods while the proportions of the robust formulation increases linearly. Jahandideh, et al., (1999) investigated the asset-liability management in the Iranian banking system with the aid of goal programming and analytical hierarchy process. The results revealed that the efficient allocation of available resources would maximized bank profit and likewise minimize risk in the Iranian banking system. However, the major defect of this study is an application of the analytical hierarchy process that is subject to an artificial limitation of a point scale, several pairwise comparisons may become very large and also Iranian banks may consider the practical application of Shariah and non-usury law. To be in line with the literature developed so far, this paper tries to postulate a model for maximizing assets, maximizing profits, maximizing shareholders' funds, maximizing retain earnings, and optimum management items while liability was minimized using data from financial statements of Nigeria deposit money banks between 2018 to 2022 using goal programming.

Goal programming was postulated in the 1960s by Charnes and Cooper which was later developed by Ignizio (1982) and Eatman & Sealey, (1979) Goal programming model was a pioneer mathematical model used to achieve multiple objective goals in industrial and service organization. Goal programming model can be expressed through linear, nonlinear, and integer approaches. It is normally used when organizations seek to achieve more than one objective. One of the major advantages of goal programming over linear programming is the flexibility and dominion over single objectivity and stringent constraints. In addition, there are two methods of goal programming model i.e preemptive or non-Archimedean goal programming model. (Giving priority from top to bottom) and weighted goal programming model. Isermann, R. (1982) and Sherali (1982) introduced factors to the general goal programming objective function that is known as preemptive priority factors. Thus, their innovation gave rise to preemptive goal programming. These factors are ranked based on the priority given to a goal. From literature reviewed, various authors have considered different bank balance sheet management techniques. However, studies are scanty in Nigeria using goal programming to evaluate bank balance sheet management.

3.0 Methodology

This study used data extracted from three selected deposit money banks in Nigeria based on their market capitalization and performance between 2018 and 2022. However, in order to preserve institutional anonymity, their identities were withheld, and the data were therefore presented as a hypothetical scenario. This approach emphasizes the methodological and analytical objectives without undermining the confidentiality and reputation of the institutions. Therefore, this study proposed a mathematical model with the multi-objective method considering the constraints to determine the optimum allocation of assets, liability, profit shareholders fund, and retain

earnings in the balance sheet using preemptive goal programming goal programming model. Pre-emptive goal programming is normally applied when there is ordering priorities in the desired goals. The preemptive factors (P's) relationship follows:

$$P_1 >>>> P_2 >>>> P_i >>>> P_{i+1} >>>> P_m \quad (1)$$

This specified the order of their important i.e first priority or goal is important than the second, the second priority is important than the third, and this trend continues till the last priority. For an illustration, banks may prefer to achieve more of assets to liabilities and later earnings etc. Thus, the preemptive GP can be specified as stated by (Eatman & Sealey, 1979; AlArjani & Alam, 2021)

$$\min z = \Sigma_{i=1}^{n}[P_i(d_i^+ + d_i^-)] \quad (2)$$

Subject to

$$\Sigma_{i=1}^{n}(a_{ij}x_j + d_i^+ - d_i^-) = g_i(3)$$

$$d^+_i, d^-_i, \geq = 0 \quad (4)$$

where

P_i denotes the pre-emptive factor related to each competitive goal in order of preference
x_j denotes the decision variable for j = 1,2,3,,,,,,,n
a_{ij} denotes represents the coefficient of decision variables
d^+_i denotes the positive deviation variable from overachieving i^th goals
d^-_i denotes the negative deviation variable from overachieving i^th goals
g_i denotes the target value or aspiration level for i^th goals
n denotes the number of weight

Table 1:
***Using the Financial Data of a Hypothetical Bank in Nigeria*.**

Goal	2018	2019	2020	2021	2022	TOTAL
Asset	3.096	3.41	3.968	6.311	7.625	24.41
Liability	2.673	3.03	3.527	5.786	6.971	21.987
Profit	0.071	0.062	0.094	0.106	0.106	0.439
Shareholder Fund	0.455	0.515	0.491	0.192	0.751	2.404
Retain Earning	0.093	0.12	0.148	0.192	0.761	1.314
Total	6.388	7.137	8.228	12.587	16.214	50.554

Source: Authors compilation, 2026.

Table 1: The data were extracted from the financial statements of five deposit money banks in Nigeria between 2018-2022. Values were reported in trillions of naira and rounded to three decimal places.

* *The identities of the three (3) deposit money banks were deliberately withheld, and the data were presented as hypothetical values to maintain confidentiality and avoid drawing attention to the financial positions of specific institutions. This approach ensures that the study focuses on the methodological application and analytical outcomes rather than comparisons among individual ban*ks.

In this study, six major goals of a hypothetical bank in order of importance (priority) are set as follows.

P_1 denotes first priority goal of maximizing total asset
P_2 denotes second priority goal of minimizing total liabilities
P_3 denotes third priority goal of maximizing profitability
P_4 denotes fourth priority goal of maximizing shareholders fund
P_5 denotes fifth priority goal of maximizing retain earning
P_6 denotes sixth priority goal to maximizing the proportion of items value in financial statement

The decision variables (x_j) are shown as follows:
x_1 denotes the amount in the financial statement of 2018
x_2 denotes the amount in the financial statement of 2019
x_3 denotes the amount in the financial statement of 2020
x_4 denotes the amount in the financial statement of 2021
x_5 denotes the amount in the financial statement of 2022

It should be noted that there are six goal constraints has shown below:

Asset constraint: $3.096X_1 + 3.410X_2 + 3.968X_3 + 6.311X_4 + 7.625X_5 \geq 24.410$

Liability constraint: $2.673X_1 + 3.030X_2 + 3.527X_3 + 5.786X_4 + 6.971X_5 \leq 21.987$

Profit constraint: $0.071X_1 + 0.062X_2 + 0.094X_3 + 0.106X_4 + 0.106X_5 \geq 0.439$

Shareholder fund constraint: $0.455X_1 + 0.515X_2 + 0.491X_3 + 0.192X_4 + 0.751X_5 \geq 2.404$

Retain earning constraint: $0.093X_1 + 0.120X_2 + 0.148X_3 + 0.192X_4 + 0.761X_5 \geq 1.314$

Financial statement managing constraint: $6.388X_1 + 7.137X_2 + 8.228X_3 + 12.587X_4 + 16.214X_5 \geq 50.554$

- $x_1, x_2, x_3, x_4, x_5, x_6, d_1^-, d_1^+, d_2^-, d_2^+, d_3^-, d_3^+, d_4^-, d_4^+, d_5^-, d_5^+, d_6^-, d_6^+, \geq 0$

Based on the goals identified, the goal programming model is formulated as follows:

$$\min z = P_1 d^- 1 + P_2 d^+ 2 + P_3 d^- 3 + P_4 d^- 4 + P_5 d^- 5 + P_6 d^- 6 \quad (5)$$

subject to

$$3.096X_1 + 3.410X_2 + 3.968X_3 + 6.311X_4 + 7.625X_5 + d_1^- - d_1^+ = 24.410 \quad (6)$$

$$2.673X_1 + 3.030X_2 + 3.527X_3 + 5.786X_4 + 6.971X_5 + d_2^- - d_2^+ = 21.987 \quad (7)$$

$$0.071X_1 + 0.062X_2 + 0.094X_3 + 0.106X_4 + 0.106X_5 + d_3^- - d_3^+ = 0.439 \quad (8)$$

$$0.455X_1 + 0.515X_2 + 0.491X_3 + 0.192X_4 + 0.751X_5 + d_4^- - d_4^+ = 2.404 \quad (9)$$

$$0.093X_1 + 0.120X_2 + 0.148X_3 + 0.192X_4 + 0.761X_5 + d_5^- - d_5^+ = 1.314 \quad (10)$$

$$6.388X_1 + 7.137X_2 + 8.228X_3 + 12.587X_4 + 16.214X_5 + d_6^- - d_6^+ = 50.554 \quad (11)$$

It should be noted that illustration one equations 5-11 would be applied for data of illustrations two and three.

Table 2:

Using the Financial Data of a Hypothetical Bank in Nigeria.

Goals	2018	2019	2020	2021	2022	TOTAL
Asset	0.267	0.270	0.270	0.276	0.301	1.384
Liability	0.007	0.008	0.008	0.009	0.014	0.046
Profit	0.008	0.038	0.060	0.013	0.034	0.153
Shareholder Fund	0.252	0.260	0.251	0.252	0.251	1.266
Retain Earning	0.008	0.010	0.011	0.015	0.035	0.079
Total	0.542	0.586	0.600	0.565	0.635	2.928

Source: Authors compilation, 2026.

Table 2: The data were extracted from the financial statements of five deposit money banks in Nigeria between 2018-2022. Values were reported in trillions of naira and rounded to three decimal places.

Table 3
Using the Financial Data of a Hypothetical Bank in Nigeria.

Goals	**2018**	**2019**	**2020**	**2021**	**2022**	**TOTAL**
Asset	4.284	4.833	4.955	5.435	7.123	26.630
Liability	3.667	4.126	4.280	4.656	6.219	22.948
Profit	0.119	0.157	0.166	0.178	0.197	0.817
Shareholder Fund	0.398	0.410	0.436	0.523	0.477	2.244
Retain Earning	0.219	0.297	0.239	0.303	0.382	1.440
Total	8.687	9.823	10.076	11.095	14.398	54.079

Source: Authors compilation, 2026.

Table 3: The data were extracted from the financial statements of five deposit money banks in Nigeria between 2018-2022. Values were reported in trillions of naira and rounded to three decimal places.

4.0 Results and Discussion

In this section, we examined the goal achievement and deviation results of the hypothetical bank:

Table 4
Output of Hypothetical One

Goal Priority	Output Value	Goal Achievement	Negative deviation (d_i^-)	Positive deviation (d_i^+)
P_1	$d^-_1 = 0$	Fully Achieved	0	0
P_2	$d^+_2 = 0$	Fully Achieved	0	0.32933432
P_3	$d^-_3 = 0$	Fully Achieved	0.9966098×10^{-1}	0
P_4	$d^-_4 = 0$	Fully Achieved	0	0.184910×10^{-3}
P_5	$d^-_5 = 0$	Fully Achieved	0	1.122198
P_6	$d^-_6 = 0$	Fully Achieved	0	1.352064

Source: Authors compilation, 2026.

Table 4: Goal Achievement and deviation of variables of a hypothetical bank in Nigeria

Table 4 shows the results of the goal programming model for hypothetical bank one. The analysis of the target achievement and deviation variables revealed the extent to which the bank's hierarchical objectives were achieved. The first priority (P_1) was asset maximization. The target achievement outcomes were all equal to zero. This shows that all the bank's objectives were achieved, and therefore the optimal solution was established. The outcome of the deviation variables revealed that Priority One (P_1), asset maximization, was fully achieved because both the negative and positive deviations were equal to zero.d_1^- and positive deviationd_1^+ are zero, indicating that the total asset for five years did not change, which is equal to 24.410 trillion naira. That is, asset target or goal was perfectly met without any shortfall or excess deviation. The practical implication shows that bank has been operating efficiently, balance sheet stability and has a strong foundation for sustainable financial performance and long-term growth.

Furthermore, priority two (P_2) which is minimizing total liabilities, the positive deviation d_2^+ is 0.32933423, which implies that the liabilities were higher than the desired target level of the financial institution. Even though the goal was indicated as fully achieved in the model, this suggests a moderate degree of overshooting relative to the liability minimization objective of the institution. The practical implication is that the bank has been able to control its liabilities, although there is still a modest excess above the target level. It is, therefore, expedient for bank management to continuously monitor and manage its sources of funds in order to reduce financial obligations and strengthen long-term financial sustainability. In addition, priority three P_3 is maximizing profit. The positive deviation $d_3^+ = 0$ which indicated that the goal is achieved while the negative deviation d_3^- is 0.9966098×10^{-1} implies that profit can be decreased further by ₦0.9966 trillion. This further reveals that there was a shortfall in the expected profit target; that is, the achieved profit did not reach the expected goal. The practical implication of this finding is that the bank remains operationally viable despite the fact that it could not achieve its profit target. It is, therefore, necessary for the bank to improve its profit generation strategies, cost minimization measures, and resource utilization in order to enhance its financial performance and support sustainable growth.

Priority four (P_4) is maximizing shareholder's fund. The negative deviation d_4^- is 0, which indicated the goal is achieved (i.e no shortfall) also while the positive deviation d_4^+ is 0.1849180×10^{-4}. Even though the goal was achieved, the deviation is small, indicating that the achieved value slightly exceeded the target level and is practically close to full attainment. This shows that the bank has achieved an optimal level of shareholders' funds in line with regulatory requirements while avoiding substantial underachievement or excessive overcapitalization. Priority five (P_5) is maximizing retain earnings. The negative deviation d_5^- is 0.0000 indicating the goal is achieved while the positive deviation d_5^+ is 1.122198 indicates a substantial excess over the target level, meaning retained earnings significantly surpassed the planned aspiration level. The practical implication of exceeding target was that banks retain earning strategies have been highly efficient which have been resulted to adequate capital, absorb operational, credit or market-related losses, increased shareholder value

Similarly, priority six (P_6) is maximizing the proportion of items' value in a financial statement. The negative deviation d_6^- is 0.0000 indicating minimum desired proportional balance was fully achieved, while the positive deviation d_6^+ is 1.352064. This revealed that the proportional balance objective exceeded the aspiration level, suggesting that the bank has maintained a stronger financial position than anticipated in terms of the proportional distribution of its balance sheet components. The practical implication of exceeding the target serves as a stronger foundation for regulatory compliance, enhances investor confidence, supports sustainable growth, improves financial resilience, and profitability.

Table 5
Output of Hypothetical Two

Goal Priority	Output Value	Goal Achievement	Negative deviation (d^-_i)	Positive deviation (d^+_i)
P_1	$d^-_1 = 0$	Fully Achieved	0	0
P_2	$d^+_2 = 0$	Fully Achieved	0	0.1837209×10^{-1}
P_3	$d^-_3 = 0$	Fully Achieved	0.3332226×10^{-2}	0
P_4	$d^-_4 = 0$	Fully Achieved	0.111903	0
P_5	$d^-_5 = 0$	Fully Achieved	0	0.8193023×10^{-1}
P_6	$d^-_6 = 0$	Fully Achieved	0.8265781×10^{-2}	0

Table 5: Goal achievement and deviation of variables of a hypothetical bank in Nigeria

Table 5 shows the results of the Goal Programming Model for Hypothetical Bank Two. The analysis of the target achievement and deviation variables showed the extent to which the bank's hierarchical objectives were achieved. The first priority (P_1) was asset maximization. The outcome of the deviation variables revealed that Priority One (P_1) was fully achieved because both the negative and positive deviations were equal to zero, indicating that the asset target was attained without any shortfall or excess deviation d_1^+ are zero, indicating that the total assets for the five-year period did not change and were equal to ₦1.384 trillion. This, therefore, demonstrates the optimal attainment of the first prioritized goal (asset maximization). The practical implication is that the institution is operating with effective asset management.

Priority two (P_2) minimization of total liabilities was achieved, as the negative deviation is 0, while the positive deviation d_2^+ is $0.\ 1837209 \times 10^{-1}$ which implies that the liabilities exceeded the target level. Although the objective was largely achieved, the institution still experienced minimal over-targeting. The practical implication is that the institution is experiencing a moderate level of financial obligation as a result of its funding needs for operational expansion. Similarly, priority three (P_3) is maximizing profit. The negative deviationd_3^- is d_3^+ is 0.3332226×10^{-2}. This shows a relatively reduced expected profit target. Even though profit was achieved, it did not fully meet the aspiration level, reflecting minor underperformance that may be associated with cost pressures, reduced profit, and inadequate sustainable banking practices, among others. For P_4 (maximization of shareholders' funds), the negative deviation of 0.111903 indicates that the achieved shareholders' funds fell below the desired target by 0.111903 units, while the positive deviation was not specified d_4^+ is 0. This shows that the goal was achieved but it a slightly shortfall below the expected target level. The practical implication of this shows that the bank equity position was below the expected target level which may be as a result of higher reliance on external funding.

Furthermore, priority five (P_5) is maximizing retain earnings. The negative deviationd_5^- is 0.0000 indicating the goal is achieved while the positive deviation d_5^+ is 0.8193023×10^{-1} which implies that the retained earnings exceed the expected target levels. The findings reflect that the bank is having a strong capital adequacy and effective profit retention, thereby enhancing the institutions financial resilience against external shocks and institutional reinvestment capacity. For P_6 (maximization of the proportion of items' value in the financial statement) shows a negative deviation of 0.008265781 (0.8265781×10^{-2}) while the positive deviation is 0. The negative deviation of 0.008265781 revealed that there was a slight shortfall from the target. However, the extent of deviation was minimal, suggesting that the goal was substantially achieved. The

practical implication of this shows that there is a minor imbalance in the structure of the items in the bank balance sheet. It is therefore suggested that there is need for improved strategies to correct the minor imbalance in the asset, liability and equity composition of the bank.

Table 6
Output of Hypothetical Three

Goal Priority	Output Value	Goal Achievement	Negative deviation (d^-_i)	Positive deviation (d^+_i)
P_1	$d^-_1 = 0$	Fully Achieved	0	0
P_2	$d^+_2 = 0$	Fully Achieved	0	0.3023
P_3	$d^-_3 = 0$	Fully Achieved	0.8049712×10^{-1}	0
P_4	$d^-_4 = 0$	Fully Achieved	0.4606910	0
P_5	$d^-_5 = 0$	Fully Achieved	0.118573×10^{-1}	0
P_6	$d^-_6 = 0$	Fully Achieved	0.2507338	0

Table 6: Goal achievement and deviation of variables of a hypothetical bank in Nigeria

Table 6 shows the results of the goal programming model hypothetical three. The analysis of the target achievement and deviation variables revealed the extent at which the bank's hierarchical objectives were achieved. The first priority one (P_1) was asset maximization, the outcomes of target achievement are all equal to zero. This shows that all the objectives of the bank are achieved and therefore the optimal solution is established. The outcome of deviation variables revealed that priority one (P_1) asset maximization was fully achieved because both negative deviation d_1^- and positive deviation d_1^+ are zero, indicating that the asset goal was achieved without shortfall or excess deviation. This indicate that the financial institutions have good sound asset management strategies, efficient allocation of resources in their financing and investment decisions.

Priority two (P_2) which is minimizing total liabilities was fully achieved while the negative deviation is 0, the positive deviation d_2^+ is 0.3023. This implies that the liabilities exceeded the desired target level. The practical implication implies that the institutions still depend on external obligations to finance it operation even though the liability level still remained at acceptable level but it is expedient for management to strength the liability control strategies.

Similarly, priority three (P_3) is profit maximization. The positive deviation d_3^+ is 0, which indicated the goal is achieved also while the negative deviation d_3^- is 0.80478 suggesting a shortfall in the expected profit target i.e the profit realized did not fully attained the aspiration level of the financial institutions. The practical implication implies that the financial institutions earning performance was below expectation, thereby reducing its ability to generate internal funds, increase shareholder value and finance future expansion.

Priority four (P_4) is maximizing shareholder's funds. The positive deviation d_4^+ is 0, this indicated the goal is achieved also while the negative deviation d_4^- is 0.4607 which implies that the target was not fully attained. The practical implication is that the bank's equity base was lower than expected and therefore resulted in an inability to absorb financial shocks and meet the required capital adequacy standards. Therefore, management should enhance capital accumulation through retained earnings, additional equity contributions, and other appropriate measures.

Furthermore, priority five (P_5) is maximizing retain earnings. The positive deviation indicating the goal is achieved while the negative deviation d_5^+ is $0.1186 \times 10^{-}1$ which implies that d_5^+ is 0.0000 the retained earnings was reduced from the expected target level. The practical implication implies the institutions may experience challenges in financing future investment without external funding. While priority six P_6 is maximizing the proportion of items' value in a financial statement. The positive deviation (d_6^+) is 0.0000. The findings revealed that the proportional balance objective fell below the desired target level. The practical implication is that the financial institution's balance sheet was not adequately optimized and therefore required a redistribution of its assets, liabilities, and equity in order to improve operational efficiency and overall financial performance.

In addition, the results further revealed some similarities in the three banks' results because all three banks achieved optimum asset portfolio composition. These shows that the three Nigerian banks are more of assets oriented. In contrast, other variables such as liabilities, profit, shareholder fund and retained earnings are either underachieved or overachieved.

5. Conclusion and Recommendation

The objective of this study is to demonstrate the application of goal programming as a means of evaluating assets liability management using a financial statement of three Nigeria Deposit Money banks from the year 2018 to 2022. The findings from the three hypothetical Nigerian banks illustrations revealed that all the three hypothetical Nigeria deposit money bank have been able to satisfied the hierarchical objectives specified within the banking optimization framework. It should be noted that the deviation analysis shows differences between financial performance and balance sheet efficiency.

The first hypothetical scenario represented by bank one shows a strongest financial position as a result of it strong capital accumulation and it ability to optimize it balance sheet. While the second hypothetical scenario represented by bank two revealed as the most balanced performance financial institutions with minimal deviation from its objectives. However, third hypothetical scenario represented by bank three have the largest deviations indicating a weaker financial stability has been reflected in all the finding of the objectives. Nevertheless, the findings implied that effective asset maximization alone is not sufficient enough to achieve optimal financial performance and likewise optimization of liability management, capital adequacy, profitability, retained earnings, and balance sheet composition as basic requirement that must be achieve simultaneous in other to achieve sustainable banking objectives.

The findings of this study align with the principles of asset liability management (ALM) theories that emphasizes on achieving a balanced and resilient financial structure that can absorb any financial shock without undermining the long term banking sustainability. In conclusion, the application of goal programming is a valid and useful strategic application, as it identified over-achievement and underachievement and also help to define desired aspirations or benchmarks for future need under different scenarios. Future studies should also consider other financial concepts in the model such as liquidity gap and other types of risk associated with asset-liability management in Nigeria in order to identify early warning signals of bank failure and also how best to optimize balance sheets using different software such as POM QM, MATLAB, ANTIGO, etc.

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