

Optimal Loan Portfolio of Commercial Banks: A Case Study of Zenith International Bank (Nigeria) PLC

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Abstract

This study examines the application of linear programming (LP) to the loan portfolio of Nigerian commercial banks taking Zenith International Bank (Nig) Plc (ZIB) as a case study. The bank engages in diverse financial services as a commercial bank, chief of which is the advancement of loans to different classes of customers and on different tenors. The data on loan portfolio collected from the annual financial reports of the bank for 2017 were categorized and analyzed using a linear programming analytical technique embedded in LINGO software. The findings of the analysis reveal that it would have been better for ZIB to concentrate on granting of loans and advances for overdraft and term loans. By doing this, the bank can optimize returns from its loan portfolio. However, the study notes that statutory loans, particularly, on-lending which the bank cannot but advance since it is statutorily required to do so, impaired on (reduced) the value of optimal solution derived from the linear programming model. Similarly, the bank financed leases, which contradicts the optimal feasible solution of the LP model. The study recommends that the bank pays particular attention to controllable loan facilities (overdrafts and term loans) which in turn will lead to optimal revenue.

Keywords: Linear programming • Loan portfolio • Zenith International Bank • LINGO

Introduction

The banking system contributes to the growth and development of the economy through the loans it grants to the different sectors that make up the economy. Otting asserts that lending is the major business that commercial banks engage in because it forms the principal part of their assets on one hand, and the main revenue generator, on the other. These loans and advances have different tenors, characteristics and risks attached to them. Loans can be for long, medium or on short term basis; secured or unsecured. It can also be to finance manufacturing, real estate, commerce or service. The tenor of loan and other characteristics attached to it are the determinants of the terms of the loan with respect to repayment and interest payable. Otting defines loan portfolio management as the process through which a bank manages the risks inherent in granting loans and advances to borrowers. This requires that banks, in addition to knowing the risks attached to each credit portfolio, must understand the interrelationship the risks of individual loans and portfolio. Maintaining optimal loan portfolio is one of the major problems faced by bank managers and proper management of loan and credit portfolio is germane to a sound and safe bank. Failure to effectively manage credit risks arising from loan

and advances will plunge a bank to financial crises [1].

The submission that commercial banks can reap substantial advantage through efficient management of their loan portfolio continues to garner acceptance among operators in the industry [2]. However, conflict arises when banks want to maintain liquidity in their daily operations, on one hand, and invest in profitable investments through loans and advances, on the other. The loan portfolio of banks is of utmost importance in the achievement of the overall goals of liquidity and profitability. Tachia states that an effective loan portfolio should comprise of a carefully, broadly constructed and well diversified combination of loans that ensures maximum return and minimum risk of default. Financial mathematicians apply linear programming to resolving the crises that the liquidity-profitability conflict often breeds. Linear programming or optimization is a statistical technique used in finding the best results possible from a combination of resources or operations under a given set of constraints (that is, limited resources) [3].

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Research objectives

The broad objective of this study is to ascertain how linear programming technique can be used to achieve optimality in the way commercial banks grant loans in Nigeria. More specifically, the study will apply linear programming model to the loan portfolio of Zenith International Bank (Nig) Plc, with the aim of determining the bank's optimal loan portfolio.

Literature Review

The bank

Zenith International Bank (ZIB) Nigeria Plc is a commercial bank established in 1990, though was not listed on the Nigerian Stock Exchange until June, 2004 as a public limited company. It is also currently listed on the London Stock Exchange. The Financial Times of London (2013) rates ZIB as the biggest bank in Nigeria based on tier-1 capital, the bank can be assumed to be doing well. The total shareholders' fund grew from N20million at inception in 1990 to about N705 billion as at the end of 2017 accounting year.

According to Zenith (2019), the bank is engaged in corporate and investment banking; commercial and consumer banking; personal and private banking; foreign exchange and trade; treasury and cash management and other services. The services rendered to all these areas include deposit safekeeping, loans and advances, foreign exchange provision and advisory services. These services are rendered through several channels [4].

As it is with other commercial banks and in line with the directives of the Central Bank of Nigeria (CBN), loans and advances form a major portion of the total assets and investments of Nigerian commercial banks. For instance, loans and advances is about 41% of the total assets of ZIB in 2017. This necessitates that considerable attention be paid to the management of loans and advances by the bank in order to attain optimal return from Central Bank of Nigeria [5].

Linear programming

Linear programming (LP) is the technique of optimizing a linear objective function subject to linear equality and inequality constraints. Linear programming is arguably the best known and the most frequently used tool for solving optimization problem. Its popularity rests on its potency and great success in analyzing real world problems in all disciplines such as sociology, finance, transportation, engineering, economics, production planning, and airline crew scheduling and many others. Aniel (2011) states that LP has become a quantitative technique used by many business decision makers, particularly in relation to portfolio management, work scheduling, transportation, financial planning and many more Daniel [6].

Kanu, Ozurumba and Emeroke (2014) states that linear programming started with the work of Dantzig (1947) who is usually referred to as the originator of linear programming techniques and developed LP initially mainly to solve the challenges faced by the military in the US Air force during the World War 2, especially in the area of transportation, assignment and deployment decisions. Over the years, LP has become a powerful tool in business organizations and in other fields. The development of LP has witnessed more sophistication and advancement over the years, including well

developed mathematical and statistical packages that help to solve LP problems that otherwise would have been difficult for manual computations [7,8].

Empirical evidences

In Nigeria, there exist a few previous studies on the application of linear programming to financial institutions and financial activities of other business concerns. Agarana, Anake and Adeleke (2014) apply linear programming (LP) model to unsecured loans and bad debts risk control in banks in Nigeria. The researchers conclude that the policy of banks to reduce the volume of unsecured loan to 2% of the total short-term loan led to improvement in the overall solution and vice versa. Ekwonwune and Edebatu (2016) apply LP to financial portfolio optimization problem of Golden Guinea Breweries (Nig) Plc. The authors find that, based on the outcome of the LP optimal solution model, some of the star products of the firm do not actually contribute significantly to the profitability of the company [9-15].

Research Method

Formulating the Linear Programming Model: The Assumptions

In formulating the model that will proffer optimization to the loan portfolio of Zenith International Bank (Nig) Plc, it is necessary to outline the basic assumptions that guide the formulation of a linear programming model. Generally, there are five basic assumptions guiding the formulation of a linear programming problem. They include:

- i. Certainty: It is assumed that the numbers in the objective and constraints are known with certainty and it remains invariant throughout the time of study.
- ii. Proportionality: This means that the objective and constraints are proportional. For example, if takes 3 units of a resource to produce 6 units of a particular output, then to produce 15 units of output a total of 10 units of resources must be used.
- iii. Additivity: It is assumed that the addition of all individual activities will also equal the total of all activities in the production process.
- iv. Divisibility: The solution to a linear programming problem may take whole or fractional values.
- v. Non-negativity: All answers or variables are assumed not be able to take negative values since they are physical quantities.

Source of data

The data used in this study is secondary in nature in that it is obtained from the annual financial statements and accounts of Zenith International Bank (Nig) Plc for the year 2017. Specifically, the study used the data of the loan and advances tag in the assets segment of the balance sheet of the bank.

The decision variables and the model

We represent the loan amount allocated to specific investment type and class of loan as Xij. Table 1 contains the definition of the decision variables used in this study.

Table 1. Decision Variables in the model.

S/N	Loan Tenor/Classification	Loan Type	Lender	Decision Variables
1	Current	Overdrafts; On-lending*	Zenith Bank	X1; X2
2	Non-current	Term loans; Finance Lease	Zenith Bank	X3; X4

Source: Author's compilation (2019)

On-lending facilities are all assumed to be for working capital only. Also, Zenith International Bank (Nig) has a policy of not financing real estate/mortgage ventures as at the period of this study.

Where

X1 = the portion of total loan portfolio that is given as overdraft.

X2= the portion of total loan portfolio that is given as on-lending. X3= the portion of total loan portfolio that is given as term loans. X4= the portion of total loan portfolio that is given finance lease.

Results and Discussion

Loan portfolio of ZIB Plc

Table 2 contains the total loan portfolio of Zenith International Bank (Nig) Plc for 2017 by loan tenors and types.

Table 2. Loan granted to each category for year 2017 by ZIB.

S/N	Loan Tenor/Classification	Loan Type	Amount Loan (Nm)	of Decision Variables
1	Current (Nm) 784,059	Overdraft	480,392	X1
		On-lending	379195	X2
2	Non-current (Nm) 1,333,010	Term loans	1,253,817	X3
		Finance lease	3,665	X4
Total	2,117,069		2,117,069	

Source: Author's compilation from Annual Financial Statements of ZIB (Nig) PLC (2019)

+Before provision is made for impairment allowances.

Formulation of objective function

The objective of bank is to maximize the profit derivable from loans and advances it grants or to minimize the cost incurred on it. The objective function for the information in Table 3 is expressed as:

$$\text{Maximize } Z = pX1 + qX2 + rX3 + sX4 \dots\dots\dots (4)$$

Where

X1 = Overdraft

X2= On-lending

X3 = Term loans

X4 = Finance lease

p = Interest rate on overdraft

q= Interest rate on on-lending funds

r = Interest rate on term loans

s = Interest rate on finance lease Z

= Profit

This study used the interest rates displayed on the daily notice/interest board of Zenith International Bank (Nig) PLC as at the last business day of December 2017 as well as confirmation from insider sources, particularly with respect to finance lease. Table 3 shows the interest rates charged by ZIB on each loan type.

Table 3. Interest rate on different loan types.

S/N	Loan Classification	Loan Type	Interest rate %
1	Current	Overdraft	40
		On-lending	9
2	Non-current	Term loans	31
		Finance lease	19

Source: Author's compilation

On-lending is compulsory. These are funds lent to ultimate borrowers by the CBN through the commercial banks.

Since interest rate serves as the unit price at which the bank's loans are granted, the objective function can be expressed as:

$$\text{Max } Z = 0.4X1 + 0.09X2 + 0.31X3 + 0.19X4 \dots\dots\dots (5)$$

Formulation of constraints

To formulate the constraints for the objective function (equation 5), it is necessary to point out the policies guiding loans and advances in Zenith International Bank (Nig) Plc. The policies guiding loans by all the commercial banks in Nigeria are contained in the annual monetary and credit policy guidelines of the Central Bank of Nigeria (CBN).

According to CBN (2017), the ratio of individual bank's loan to total deposit was 80% for the years 2017. This means that Nigerian commercial banks cannot give more than 80% of their total deposits out as loans and advances.

From the financial statements, the total deposit for ZIB for 2017 is N2,744,525m and since the legally allowable loan portfolio of ZIB cannot exceed 80% of its total deposits, then the maximum loan that ZIB can give out was 80% of N2,744,525 = N2,195,620

This means that $X1 + X2 + X3 + X4 \leq 2,195,620$(6);
(Loanable fund constraint)

Secondly, according to CBN (2017), the total loans and advances made by the banking system in 2017, on the average, is distributed in the following percentages:

Current 45%

Non-current 55%

so that, $186,259 \cdot 2X + 1X \dots\dots\dots (7)$; (Current loan constraint)

$883,461,1 \cdot 4X + 3X \dots\dots\dots (8)$; (Non-current loan constraint)

The overall linear programming model now becomes

Maximize $Z = 0.4X_1 + 0.09X_2 + 0.311X_3 + 0.19X_4 \dots\dots(9)$:

(Objective function)

Subject to: $0.01 \cdot 4X + 3X + 2X + 1X \dots\dots\dots (10)$; (Current loan constraint)

$186,259 \cdot 2X + 1X \dots\dots\dots (11)$; (Current loan constraint)

$883,461,1 \cdot 4X + 3X \dots\dots\dots (12)$; (Non-current loan constraint)

$2,1 = j \text{ dna } 2,1 = i; 0 \cdot j \cdot X \dots\dots\dots (13)$; (Non-negativity constraints)

Solving a linear programming problem

There are two main approaches to solving LP problems: The Graphical and the Simplex Methods. While the graphical method appears simple and easy to use, the major shortcoming with it is that it can only be applied to a two-decision variables case. Thus, the simplex method, though more rigorous, can be used to solve problems involving several decision variables.

Solving both simple and complex LP problems has, over the years, become a lot easier with the development of mathematical and statistical packages that are designed to solve optimization problems. Such packages include LINGO, LINDO, SOLVER, and STATA etc.

In order to solve for optimal loan portfolio of ZIB, the linear programming model (from equations 7 and 10) is formatted and imputed into LINGO statistical package which analyzes the information and generates the optimal feasible solution. The model is stated as:

Max $0.4X_1 + 0.09X_2 + 0.31X_3 + 0.19X_4$

S.T.

$0.01 \cdot 4X + 3X + 2X + 1X$

$186,259 \cdot 2X + 1X$

$883,461,1 \cdot 4X + 3X$

End

The formatted equations above are thereafter copied and pasted on the blank page on LINGO or LINDO analyzer. Once these equations are pasted, the results can be generated by pressing the Solver button.

Source: Author's computation with LINGO (2019)

From the results in Table 3, the optimum solution for the linear programming model is:

$X_1 = 952,681$

$X_2 = 0.00000$

$X_3 = 1,164,388$ $X_4 =$

0.00000

with a corresponding optimal return value of about N742,033m. The reduced cost column shows the reduction on the value of the optimal solution if ZIB chooses to still finance X_2 and X_4 . Furthermore, the slack variables have no negative value, implying that all the variables satisfy the equality constraints.

Interpretation of results

The results above reveal that in order for Zenith Bank to maximize its profit, the bank should grant its loans and advances as shown in Table 4.

Table 4. Loan to be granted to each category for year 2017 by ZIB.

S/N	Loan Classification	Tenor/ Loan Type	Amount of Loan (Nm)
1	Current (Nm)	Overdraft	952,681
		On-lending*	379,195
2	Non-current (Nm)	Term loans	1,164,388
		Finance lease	0
Total			2,496,264

Source: Author's computation (2019)

Note that on-lending, being an advance that the Central Bank mandates the bank to give to the beneficiaries must be reflected in the loan portfolio in spite of the fact that it may impair on the optimal solution (reduce profit by 0.3100000)

According to the outcome of the LP programming model, ZIB should grant N1,331,876 (N952,681m + N379,195m) and N1,164,388 to current (short term) and non-current (long term) borrowers respectively.

Inserting these optimal solutions into the objective function, we have:

Max $Z = 0.4(952,681) + 0.09(0) + 0.31(1,164,388) + 0.19(0)$

$Z = 742,033$

The maximum realizable revenue from the best loan portfolio of ZIB for the year 2017 is N742, 033m.

However, since ZIB must advance the on-lending facilities to the beneficiaries, a penalty (reduced cost) of about N310m will be made on the estimated optimal profit. But since we are dealing with historical data, the bank also engaged in finance lease, which according to the optimal solution will further reduce the revenue by N120m. The value of the optimal solution will now be:

$N(742,033 - 310 - 120)m = N741,603$

The actual revenue of ZIB from the bank's annual financial statement for 2017 is N 673,636m. This means that, with regard to ZIB loan portfolio, the optimal feasible solution was not achieved in 2017 as there existed a whopping difference of N 67,967m (741,603 – 673,636) in revenue which was not achieved during the year.

Summary and Conclusion

Summary

This study set out to apply linear programming optimization technique to the loan portfolio of Zenith International Bank (Nig) Plc, a quoted commercial bank in Nigeria, for the 2017 financial year. The loan portfolio of the bank was made up of current (short-term) and non-current (medium and long-term) loan facilities. Furthermore, the bank granted loans and advances to four (4) principal areas of financing: overdraft, on-lending, term loans and finance lease. This study reliably assumes that overdrafts and on-lending are current in nature because though the on-lending facilities comprise of short and long term lending, there was no clearly stated figures to distinguish them. The non-current loan consists of term loans and finance lease.

The interest rates charged on each of these classes of loans as well as the ratio of long to short-term loans were sourced from the monetary and credit policy guidelines of the Central Bank of Nigeria and insider information from the bank.

In order to determine the optimal loan portfolio that ZIB ought to have employed, linear programming method was used to analyze the objective function and the given constraints.

Conclusion

The results showed that, for the financial year 2017, ZIB's loan portfolio was not at the optimal level and that the bank could still perform better in terms of revenue if it had maintained a loan portfolio as determined by the results of this analysis.

The reasons for the non-optimal revenue to ZIB are not farfetched. First, and essentially too, Nigerian commercial banks are subjected to stringent operating rules, laws and regulations by the monetary authority, especially the CBN. These regulations limit the scope, volume, cost and direction of credits by the commercial banks. Good as they appear, directives by the CBN relating to maximum chargeable interest rates, liquidity ratios, sectorial allocation of fund, on-lending mandates, and rediscount rates among others sometimes impair on banks' ability to evolve optimal loan portfolios.

Secondly, another factor is the assumptions guiding the application of linear programming, which, to a large extent, are unrealistic. As potent as linear programming is in solving optimization problems, its limitations lie in the assumptions upon which the analysis is based. The real life planning process may not be solvable through linear programming because apart from the difficulty in deciding exactly what the objective function is, the determination of social, institutional, financial and other constraints may not be easy as it appears. Real life situations reveal that relations are not always linear in nature because of the existence of imperfections in the market. For instance, the common practice among commercial banks is to charge different interest rates for different classes of borrowers, depending on their credit worthiness and other factors.

Limitation and Suggestion for Further Studies

Decisions such as appropriate loan portfolio of banks should rely more on current or expected figures rather than on historical data. A major limitation of this study is the non-availability of present period or expected (forecasted or futuristic) data from Zenith International Bank (Nig) Plc. Also, some of the available data may not be applied to the day-to-day operations of the bank. Certainly, there are "behind the scene" activities that exert much influence on interest rates on loan, for instance.

Further study is advocated to determine the expected optimal loan portfolio where the analysis will make use of expected (or reliable forecasts) by the bank. By doing this, the bank will be able to strategically plan ahead for optimality in the face of constraints.

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