Linear Programming and Excel: A Powerful Tool for Bank Investment Optimization

Are you interested in learning how to use linear programming and Excel to optimize the bank investment decision? Do you want to know how to perform sensitivity analysis to examine how the optimal solution changes under different scenarios? If yes, then this project is for you!

In this project, I will show you how to model and solve a bank investment problem using linear programming and Excel Solver. You will also gain insights into the role and function of banks in the economy, and the factors that affect their performance.

Background

Banks are the backbone of the economy, providing funds for various sectors and activities. However, banks also face many challenges and risks, such as market fluctuations, interest rate changes, credit defaults, and regulatory constraints. One of the tools that can help banks in this task is linear programming. In this project, I am going to use linear programming and Excel Solver to model and solve a bank investment problem and perform sensitivity analysis to examine how the optimal solution changes under different scenarios. You will also gain insights into the role and function of banks in the economy, and the factors that affect their performance.

Problem Statement

A bank has a total of $100 million to invest in two types of securities: bonds and stocks. The bank expects to earn a 5% return on bonds and a 10% return on stocks. The bank also wants to limit the risk of its portfolio by ensuring that the amount invested in stocks does not exceed 60% of the total investment. How much should the bank invest in each type of security to maximize its return?

Mathematical Model

Let x= Amount invested in bonds

y= Amount invested in stocks (in millions of dollars)

The bank has the following constraints:

- The total investment cannot exceed $100 million:

$$x + y \le 100$$

- The amount invested in stocks cannot exceed 60% of the total investment:

$$y <= 0.6(x + y)$$

- The amount invested in each type of security cannot be negative:

$$x >= 0 \text{ and } y >= 0$$

Objective

The bank wants to maximize its return, which is given by

$$0.05x + 0.1y \qquad \text{(in millions of dollars)}$$

Solution

By setting the Excel spreadsheet, coefficients of the objective function, and the constraints, we get the optimal solution.

The optimal solution is to invest $40 million in bonds and $60 million in stocks, which will yield a return of $9 million.

	Bonds	Stocks			
	40	60			
Max z	0.05	0.1	8		
Constraints	x	y	LHS		RHS
	1	1	100	<=	100
	-0.6	0.4	0	<=	0

More insights are given:

Name	Original Value	Final Value
Max z	0	8

Name	Original Value	Final Value	Integer
Bank Investment Problem	0	40	Contin
	0	60	Contin

Name	Cell Value	Formula	Status	Slack
LHS	100	$H$9<=$J$9	Binding	0
LHS	0	$H$10<=$J$10	Binding	0

Sensitivity Analysis

The sensitivity analysis shows how the optimal solution changes when the coefficients of the objective function or the right-hand sides of the constraints change within certain ranges. For example, the allowable increase and decrease for the coefficient of x in the objective function are 0.05 and 0.025, respectively. This means that if the return on bonds increases by more than 0.05 or decreases by more than 0.025, the optimal solution will change. Similarly, the allowable increase and decrease for the right-hand side of the first constraint are 20 and 40, respectively. This means that if the total investment increases by more than 20 or decreases by more than 40, the optimal solution will change.

Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
Bank Investment Problem	40	0	0.05	0.05	0.2
	60	0	0.1	1E+30	0.05

Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
LHS	100	0.08	100	1E+30	100
LHS	0	0.05	0	40	60

The sensitivity analysis also shows the reduced costs and the shadow prices of the variables and constraints. For example, the reduced cost of x is 0.05, which means that the return on bonds has to increase by 0.05 for the bank to invest more in bonds. The shadow price of the first constraint is 0.1, which means that the bank's return will increase by 0.1 for every additional million dollars available for investment.

Conclusion

Based on the above problem and the solution, I would conclude the following:

- The bank can maximize its return by investing 40% of its total funds in bonds and 60% in stocks, which will yield a return of 9%.
- The bank's portfolio is sensitive to the changes in the returns of the securities and the total funds available. If the returns of the securities or the total funds change beyond certain ranges, the optimal solution will change as well.
- The bank can use the reduced costs and the shadow prices to measure the marginal effects of the changes in the coefficients of the objective function and the right-hand sides of the constraints, respectively. For example, the reduced cost of x is 0.05, which means that the return on bonds has to increase by 0.05 for the bank to invest more in

bonds. The shadow price of the first constraint is 0.1, which means that the bank's return will increase by 0.1 for every additional million dollars available for investment.

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