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The use of financial engineering products in managing interest rate risk "National Bank of Algeria as a model"

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Abstract---Financial risk management is the practice of protecting the economic value of a company by using financial engineering tools to manage exposure to risks such as operational risks, credit risks, market risks, foreign exchange risks, and interest rate risks. This article seeks to highlight one of the most common types of financial risks in financial markets, which is interest rate risk, and how to manage it using the tools provided by financial engineering. These tools enable those responsible for managing these risks to propose appropriate solutions and devise alternative plans that ensure a balance between financial assets and liabilities, thus helping banking institutions avoid financial failure and manage their assets and deposits in a flexible and rational manner.

Keywords---Financial engineering products, Interest rate risk, Risk Management, Interest Rate Swaps.

Introduction

In the ever-evolving landscape of modern finance, the effective management of financial risks is paramount for the survival and success of financial institutions. These institutions are exposed to a variety of risks, including operational, credit, market, foreign exchange, and interest rate risks. Among these, interest rate risk (IRR) is particularly significant for institutions that deal with interest-sensitive financial products, such as banks, insurance companies, and investment firms. Interest rate fluctuations

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can have a profound impact on both the profitability and stability of these organizations, as changes in interest rates influence the value of assets and liabilities, as well as the cost of funding.

Interest rate risk typically arises due to the mismatch between the maturity and re-pricing characteristics of an institution's assets and liabilities. If the interest rates on liabilities rise faster than the rates on assets, the institution could face a decline in profitability or even solvency. In response to this, financial engineering has emerged as a crucial tool to help manage and mitigate this risk. Financial engineering refers to the application of mathematical models, computational techniques, and innovative financial products to solve complex financial problems, such as the management of interest rate risk.

Among the key tools developed within the field of financial engineering, derivatives such as interest rate swaps, futures, options, and forward rate agreements have gained widespread use. These financial instruments enable firms to hedge against fluctuations in interest rates, providing a mechanism to lock in future rates or to offset the impact of adverse rate movements. Through the use of these instruments, financial institutions can better align their risk profiles with their strategic objectives, protecting their portfolios from unpredictable shifts in the interest rate environment.

The significance of financial engineering in managing interest rate risk has grown in recent years, particularly as global financial markets have become more interconnected and volatile. The growing complexity of financial instruments, alongside the advent of more sophisticated modeling techniques, has allowed financial professionals to design tailored solutions that meet the specific needs of their institutions. For instance, banks use swaps and derivatives to manage the risk of their loan portfolios, while insurance companies employ similar techniques to hedge against liabilities linked to interest rate movements.

The role of financial engineering in risk management is not limited to mitigating losses. In fact, the proper use of financial engineering tools can also enhance financial flexibility and optimize portfolio performance. By effectively balancing risk and return, institutions can reduce the likelihood of financial distress and improve their competitive position in the market. Moreover, sound interest rate risk management strategies are crucial for maintaining regulatory compliance, particularly in light of the stricter capital and liquidity requirements that have emerged after the global financial crisis of 2008.

In light of the above, we will address the issue of how banking institutions utilize financial engineering products and tools in managing a type of financial risk that is widely prevalent in financial markets, specifically interest rate risk. The central research question can be summarized as follows: What is the role of financial engineering products in managing interest rate risk at the National Bank of Algeria (B.N.A)?

This paper explores the role of financial engineering products in the management of interest rate risk. It highlights how these tools can be applied to various financial contexts, discusses their potential benefits and limitations, and examines their impact on both institutional risk management and broader market stability. By analyzing the use of these financial products, the paper seeks to provide a comprehensive understanding of how financial engineering can contribute to the sustainable management of interest rate risk, helping institutions navigate the challenges of an increasingly complex financial environment.

Literature Review

The management of interest rate risk is a fundamental concern for financial institutions, particularly banks, which have significant exposure to fluctuations in interest rates due to their lending and borrowing activities. Interest rate risk arises when there is a mismatch between the maturities or re-pricing schedules of a financial institution's assets and liabilities (Koch & MacDonald, 2015). Over time, various tools have been developed to manage this risk, and financial engineering plays a critical role in

designing products to hedge or reduce the exposure to interest rate fluctuations (Hull, 2017). This literature review explores the evolution of financial engineering products for interest rate risk management, the different strategies employed by financial institutions, and the theoretical foundations behind these tools.

1. The Nature of Interest Rate Risk

Interest rate risk arises from changes in the market interest rates, which can impact the cash flows of an institution, its ability to meet obligations, and the value of its assets and liabilities (Chance & Brooks, 2015). The risk is particularly significant for banks, which have a higher exposure due to their asset-liability structure (Wilmott, 2006). Banks typically hold long-term fixed-rate loans funded by short-term deposits, leading to a mismatch in the maturity profiles of assets and liabilities (Mishkin, 2015).

Interest rate risk management involves anticipating and mitigating the impact of interest rate changes through strategies that involve various financial instruments. Early theoretical work on interest rate risk management focused on duration and gap analysis, where institutions matched the duration of their assets and liabilities to reduce exposure to interest rate fluctuations (Tuckman, 2012).

2. *Financial Engineering and Derivatives*

The rise of financial engineering has led to the development of derivatives as essential tools for managing interest rate risk. Financial derivatives, such as interest rate swaps, options, futures, and forwards, allow institutions to hedge against adverse changes in interest rates by altering the cash flow patterns associated with their portfolios (Black & Scholes, 1973; Jorion, 2007). Derivatives can be customized to fit the specific needs of financial institutions, thus enabling them to better manage their exposure.

Interest rate swaps, for example, allow institutions to exchange fixed interest payments for floating ones or vice versa, thus aligning their asset-liability structure with their risk tolerance (Harrison & Kreps, 1979). In a similar vein, forward rate agreements (FRAs) and futures contracts provide a mechanism to lock in interest rates for future periods, helping to reduce the uncertainty associated with future cash flows (Brennan & Schwartz, 1982).

3. The Role of Interest Rate Swaps

Interest rate swaps have been widely adopted as a tool to manage interest rate risk. In an interest rate swap, two parties agree to exchange periodic interest payments on a notional principal amount, with one party paying a fixed rate and the other paying a floating rate. This allows institutions to hedge against fluctuations in interest rates by locking in fixed payments on floating-rate liabilities or vice versa (Brennan & Schwartz, 1982; Fabozzi, 2001). The popularity of interest rate swaps has been particularly evident in the banking sector, where they help manage the mismatch between the interest rates on loans and deposits (Tuckman & Serrat, 2011).

Research has shown that interest rate swaps are effective in reducing a bank's exposure to interest rate risk and can enhance its profitability when interest rate movements are unpredictable (Chance & Brooks, 2015). However, critics argue that swaps may introduce counterparty risk and that excessive use of swaps can lead to significant losses if not properly managed (Jorion, 2007).

4. Interest Rate Futures and Options

Futures contracts have also become an essential part of interest rate risk management. Interest rate futures are standardized contracts that allow financial institutions to buy or sell debt instruments at a predetermined price at a future date. These contracts are useful for hedging against changes in interest rates, as they provide a mechanism for locking in future borrowing or lending costs (Black & Scholes, 1973). Futures contracts are particularly attractive due to their liquidity and ease of use compared to other derivatives.

Similarly, interest rate options, such as caps, floors, and collars, allow institutions to set upper and lower limits on interest rate movements. These options provide flexibility in managing interest rate exposure,

as they offer protection against unfavorable rate changes while still allowing institutions to benefit from favorable movements (Black, 1976; Hull, 2017).

5. Theoretical Models of Interest Rate Risk Management

Several models have been developed to analyze and optimize interest rate risk management. One of the earliest and most influential models is the **duration model**, which measures the sensitivity of the price of an interest-sensitive asset or liability to changes in interest rates (Macaulay, 1938). Duration analysis helps institutions determine the level of interest rate risk associated with their portfolios and develop hedging strategies to reduce exposure (Mishkin, 2015).

Another critical model in the management of interest rate risk is the **term structure model**, which examines the relationship between short-term and long-term interest rates (Nelson & Siegel, 1987). These models are used to forecast future interest rates and to identify optimal hedging strategies based on the shape of the yield curve (Vasicek, 1977).

6. Empirical Evidence on the Effectiveness of Financial Engineering Products

Empirical studies have demonstrated that financial engineering products, particularly interest rate derivatives, are effective tools for managing interest rate risk. Studies by Fabozzi and Mann (2005) and Anderson and Sundaresan (1996) show that the use of interest rate derivatives can significantly reduce the volatility of financial institutions' earnings, thus improving their overall financial stability. Furthermore, research by Nuno and Duarte (2012) suggests that financial engineering tools provide a cost-effective means of managing interest rate risk when compared to traditional risk management methods.

However, some studies highlight the risks associated with derivative instruments. For instance, Whaley (2002) discusses how excessive use of derivatives without proper risk management frameworks can lead to substantial losses. The global financial crisis of 2008 further highlighted the importance of effective oversight and risk management in the use of derivatives (Ferri, 2009).

7. Regulatory Perspectives

In the aftermath of the 2008 financial crisis, regulatory bodies such as the **Basel Committee on Banking Supervision** and the **Financial Stability Board** have imposed stricter requirements on banks and financial institutions to manage interest rate risk and other types of financial risks. These regulations emphasize the importance of capital adequacy and liquidity management in reducing exposure to market risks (BCBS, 2017).

The introduction of the **Dodd-Frank Act** in the United States and the **European Market Infrastructure Regulation** (EMIR) has further reshaped the regulatory landscape for the use of financial derivatives. These regulations aim to enhance transparency and reduce systemic risk by requiring financial institutions to clear derivatives through central counterparties and adhere to stricter reporting and capital requirements (Hull, 2017).

8. The Future of Interest Rate Risk Management

As financial markets continue to evolve, the need for advanced risk management techniques has become even more pronounced. The advent of **machine learning** and **artificial intelligence** in financial engineering is opening new frontiers in risk management, allowing institutions to model interest rate risk more accurately and devise more sophisticated hedging strategies (Bianconi & Cincotti, 2011). Additionally, the increasing complexity of financial markets, along with the growing use of non-traditional assets such as cryptocurrencies and blockchain-based financial products, presents both new opportunities and challenges for interest rate risk management (Gorton & Zohar, 2016).

The literature on financial engineering and interest rate risk management illustrates the importance of using sophisticated financial instruments to mitigate the impact of interest rate fluctuations on financial institutions. Through the use of derivatives, such as swaps, options, and futures, banks and other financial institutions are able to hedge against interest rate movements, thus enhancing their financial

stability. However, the effective use of these tools requires a deep understanding of financial markets, regulatory frameworks, and risk management strategies to ensure their benefits are fully realized.

Introduction to the National Bank of Algeria (BNA):

The National Bank of Algeria (BNA) stands out as a premier local bank with 227 branches, overseen by 21 regional management offices spread across the country. Given its complete investment in digitizing its products and services, as well as expanding its range of digital payment methods, the BNA leads in terms of the number of free banking cards issued to its customers. To facilitate their daily banking operations, the bank has also installed 100 automated teller machines (ATMs) and 171 cash dispensing machines.

Since its establishment in 1966, the National Bank of Algeria has been serving its customers—whether individuals, professionals, or institutions. This mission remains its core, making it one of the most active banks in the Algerian banking sector, with over 2.5 million customers.
Through its 227 branches distributed nationwide, the bank's organizational structure will be briefly presented. The branch is considered the fundamental unit of the National Bank of Algeria system, and can be viewed as a miniaturized version of the larger banking structure. Each branch strives to implement and achieve the bank's broader objectives.

Using Financial Engineering Products in Managing Interest Rate Risk at the National Bank of Algeria (BNA):

The National Bank of Algeria (BNA), like other banks, has a range of financial resources that differ according to their nature. Generally, the sources of the bank are:

- **Bank Capital**: This is the portion allocated to the start of the project, representing the total invested funds in the project. Capital can be in the form of either tangible or intangible assets provided by partners during the establishment of the company. Capital is a critical source of funds for the bank and must be sufficient to meet the bank's needs.
- **Reserves**: The National Bank of Algeria, like other banks, sets aside reserves to ensure the stability of deposits, including fixed deposits, and to protect them from loss. Another reserve is used to balance the realized profits, alongside various other reserves needed due to the nature of the bank's activities. These reserves allow the bank to cover potential future losses and act as a safeguard for depositors' funds.

Objectives of Risk Management at the National Bank of Algeria (BNA):

Since most of the BNA's products are loans and financing based on debt contracts—most of which are deferred payment types—these loans generate debts on the bank's books. As a result, these types of financing face multiple risks that require hedging.
The BNA is fully committed to promoting and institutionalizing risk management culture, viewing it as an essential condition for successful and effective performance. Below are the key objectives of risk management at BNA:

- Maintain a precautionary and organized approach to risk-taking by adhering to a comprehensive set of risk management policies, procedures, and limits.
- Employ qualified personnel with the necessary skills.
- Invest in technology and training.
- Actively promote a healthy risk management culture at all levels and for all activities.
- Maintain clear separation of duties and work plans between individuals executing tasks and those overseeing the risks arising from them.
- Maximize shareholder value while continuing business growth and geographical expansion.

BNA Financing Products:

The National Bank of Algeria offers its products through a range of financing methods for its customers, including:

- Operating financing through cash
- Financing for raw materials and semi-finished goods
- Financing for goods intended for resale
- Financing for receivables
- Investment financing
- Traditional investment financing
- Leasing financing
- Housing financing
- Home renovation financing
- Financing for passenger and utility vehicles
- Financing for professional equipment and machinery

The financing amount can reach 90% of the value of the assets or projects being acquired or invested in, with loan durations reaching up to 40 years.

Methods of Managing Interest Rate Risks:

Changes in market interest rates can have a positive or negative impact on security prices. When market interest rates rise, the prices of securities tend to fall, and vice versa. The decline in security prices due to rising interest rates is due to the availability of new investment alternatives offering relatively higher returns compared to the risks of older investments. This may cause some investors to sell their older investments and shift to new deposits and bonds.
In general, at the National Bank of Algeria, interest rate risk arises from various sources, including:

- **Changes in interest rates** (absolute interest rate risk)
- **Changes in the yield curve** (yield curve risk)
- **Misalignment between exposure management strategies and risks** (basis risk)

Interest rate risk is the potential adverse effect on profitability or the value of assets resulting from changes in interest rates. Interest rate risks affect many institutions, including borrowers and investors, and especially industries that are capital-intensive.
Absolute Interest Rate Risk arises from the possibility of interest rates moving either higher or lower. Most financial institutions, including the BNA, consider this risk when estimating its potential impact on profitability.

Yield Curve Risk:

The yield curve reflects the relationship between interest rates and the time to maturity at a given moment. A positive yield curve occurs when long-term interest rates are higher than short-term rates, while a negative yield curve occurs when short-term rates are higher than long-term rates. A flat yield curve occurs when interest rates for short-term and long-term periods are equal.
Understanding this relationship between interest rates and maturity is crucial for assessing interest rate risks for the following reasons:

1. Interest rates are constantly changing, leading to instability in net interest income.
2. Future borrowing or lending interest rates are unknown, so hedging must be done in advance.
3. Banks typically borrow short-term and lend long-term, assuming that long-term lending rates will be higher than borrowing costs due to the positive margin between long-term and short-

term interest rates. As such, net interest income is affected by changes in the shape of the yield curve.

Interest Rate Risk Effects on Net Interest Income:

- **Decline in Net Interest Income**: Banks that hold assets sensitive to interest rate changes greater than their interest-sensitive liabilities face the risk of lower net interest income. A decrease in interest rates will reduce the income earned on assets (loans and investments) more than the reduction in interest expenses on deposits, leading to a drop in net interest income. Conversely, if a bank holds liabilities (deposits) that are more sensitive to interest rates than its assets (loans and investments), an increase in interest rates will raise the cost of interest paid on deposits more than the increase in interest income from assets, thus reducing net interest income.
- **Decline in Market Value**: Banks are also exposed to the risk of a decline in market value. This occurs because the market value of assets or liabilities is based on the current value of expected future cash flows, discounted by the prevailing market interest rates. If interest rates rise, the market value of these assets or liabilities falls, and vice versa. Additionally, if a bank holds assets with longer maturities than its liabilities, an increase in interest rates will reduce the value of those assets.

Managing Interest Rate Risks:

Due to the fluctuations caused by changes in interest rates, banks must identify, measure, and control these risks. One key strategy employed by commercial banks, including BNA, is the use of interest rate swaps to hedge against interest rate risks.
In the case of a negative gap, the bank assumes the position of paying a fixed rate cash flow and receiving a floating rate cash flow. In the case of a positive gap, the bank assumes the position of paying a floating rate cash flow and receiving a fixed rate cash flow.
The following table shows the effects of interest rate changes on the interest margin (not provided here but would typically include the detailed data).

The following table shows the effects of interest rate changes on the interest margin:

case	Effect of Interest Rate Increase on Interest Margin	Effect of Interest Rate Decrease on Interest Margin
Positive Gap	Profit	Loss
Negative Gap	Loss	Profit
No Gap	No Impact on Margin	No Impact on Margin

Interest rate risks arise from the potential impact of changes in interest rates on the value of other financial assets. Banks are exposed to interest rate risk due to mismatches or gaps between the amounts of assets and liabilities based on different time periods, or due to the periodic adjustment of interest rates over a certain period. Banks manage these risks by reviewing the interest rates on their assets and liabilities through a risk management strategy overseen by the Asset and Liability Committee. They follow a financial hedging policy for both financial assets and liabilities whenever necessary, addressing anticipated future risks.

The bank develops scenarios to measure the sensitivity to interest rate risks and provides a system to monitor the differences in repricing, ensuring proper control and risk reduction, taking into account acceptable risks, and balancing the maturity profiles of assets and liabilities, along with interest rate gaps and hedging strategies.

Changes in market interest rates can negatively affect the bank's financial position, especially by directly impacting the bank's income (net interest income). One of the main interest rate risks is **repricing risk**, which arises from differences in the maturity dates (for fixed interest rates) and the repricing dates (for variable interest rates) of the bank's assets, liabilities, and off-balance-sheet items. For example, if a bank funds a long-term loan with a fixed interest rate using a short-term deposit with a variable interest rate, the bank will face a reduction in future income if interest rates rise. The decline occurs because the cash flows from the loan remain fixed over the loan's duration, whereas the interest paid on the deposit is variable.

The risk assessment starts by determining a schedule for distributing interest-sensitive assets, liabilities, and off-balance-sheet items across time periods according to their maturity dates (for fixed interest rates) and repricing dates (for variable interest rates). The impact of falling interest rates on the bank's profits and the value of its assets is then determined.

Conclusion

Like other banks and financial institutions, the National Bank of Algeria (BNA) is committed to thoroughly analyzing all proposals and implementing the best practices to make sound decisions aimed at avoiding the various risks associated with its activities, its customers, or the environment in which it operates. This study focused on interest rate risks and how they are managed. As previously mentioned, interest rate risks arise when there is a mismatch or gap between interest-sensitive assets and liabilities. This mismatch can occur when the bank holds long-term assets against short-term liabilities, exposing it to refinancing risks, which arise from the possibility that the cost of re-borrowing funds may exceed the returns generated from lending and investing those funds. By effectively managing these risks, especially interest rate risk, the BNA aims to safeguard its financial stability and protect its customers and shareholders from adverse effects caused by fluctuations in market interest rates.

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