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Some Applications of Mathematics in Finance Sector

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Abstract: *The complexity of financial transactions in the world of real stock markets and industry at large cannot be understated. Mathematics is critical to the finance sector. The use of mathematics and statistics within the field of finance has been increasing substantially in the past and will continue to increase. The present study is to determine the best bank for the consumers. In the following paper, we have studied and analyzed various modes of payments a bank provides and chose the best bank among them individually. Obtained results are compatible with the present rates of individual banks.*

Keywords: *Financial Mathematics, Cash Flow, Interest Rate, Annuity, Time Period.*

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Introduction:

The word 'Finance' has been derived from the Latin word 'finis' and from the old French word 'fin' which originally meant 'end'.

The field of mathematical finance is concerned with financial markets and is a branch of applied mathematics. The discipline of financial economics, which is concerned with the underlying theory, has a tight association with this subject. Financial mathematics is concerned with the application of mathematics to financial problems, and the analysis of financial data. Probability, statistics, stochastic processes, and economic theory are all used. Several authors have been working to study the roles of mathematics in finance sector (Yang, 2017; Tularam, 2013).

When it comes to finance and business, time is vitally valuable. Taking into consideration that time passes, we have time value of money/transactions. The basic aspect of accounting science is to figure out how financial agents distribute limited-time resources. Financial decisions are made in terms of either expenses (expenditure) or earnings (inflows) when it comes to the time distribution of resources (Jha, 2020).

Traditionally, financial mathematics methods have been used by investment banks, commercial banks, hedge funds, insurance firms, corporate treasuries, and regulatory agencies to solve problems including derivative securities valuation (Sreelatha, 2018), portfolio structuring, risk management, and scenario simulation. Financial mathematics is also used in commodity-based industries (e.g., energy and manufacturing).

Quantitative analysis has improved the efficiency and rigor of financial markets and investment processes, and it is becoming more relevant in regulatory concerns. As a subfield of economics, quantitative finance is concerned with the valuation of assets and financial instruments as well as the allocation of measures. This shows how fundamental variables like asset values, market movements, and interest rates are related.

Materials and Methods:

Starting with the cash flow diagrams, it is basically a diagrammatic representation of the cash/monetary transactions or the transactions in the terms of a receipts and disbursements at different time values (Jha, 2020). At any point, we have either income or expenditure, if we move to the positive side, it is receipt and if we move to the negative, it is disbursement.

It is actual inflow (receipt) and outflow (disbursement) of different points in time occurring over the period of investment Net cash flow at any time 't' is the arithmetic sum of receipts (+) and disbursements (-) that occurs at same point in time. First, we define some terms which are used in this paper (Jha, 2020).

There are different types of cash flow:

Single Cash Flow: In this type of cash flow, there is only one transaction, i.e., if we have received some amount today as a loan, then we have to pay that same amount at the end because ultimately, we have only a single transaction.

In this we have Single Payment Compound Amount Factor. It is the factor which when multiplied with the present (or the current) value gives us the future value (or the compound amount). Its cash flow diagram is represented as follows

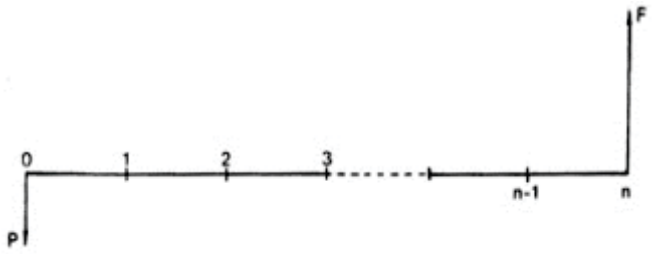

Fig. 1. Single Payment Compound Amount Factor Cash Flow

We know that

$$F = P(1+i)^n$$

And so $(1+i)^n$ is the Single Payment Compound Amount Factor (CAF). So, this factor which on multiplication with P (present value) gives us F (future value), so basically it is known as

$$(F/P, i, n)$$

So, this is Single Payment Compound Amount Factor. It is nothing but

$$(F/P, i, n) = (1+i)^n$$

Equal or Uniform Cash Flow: In this type of cash flow, there may be 'n' transactions, i.e., if we have received some amount today as a loan, then we can repay that amount in equal series manner (can be monthly, yearly, etc.). In this we have

(a) Equal Payment Series Compound Amount Factor: Here, we find the future amount 'F' (or compound amount) provided 'A' (annuity) is given at every year end based on the rate of interest 'i' and the number of times the compounding is taking place or the number of years. So, by looking at the cash flow diagram, it is nothing but in every year end we are depositing certain amount that is fixed.

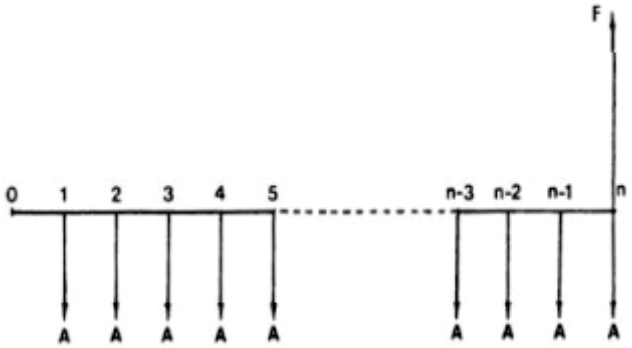

Fig. 2.1 Equal Payment Series Compound Amount Factor Cash Flow

It is represented by the symbol (F/A, i, n).

So, Equal Payment Series Compound Amount Factor is generally a factor when multiplied with equal annual amount gives future value or compound amount provided the rate of interest is known. Therefore,

$$(F/A, i, n) = \frac{[(1+i)^n - 1]}{i}$$

(b) Equal Payment Series Capital Recovery Factor: When we talk about finance related issues or economics related matter, then in those cases, we know that whenever we have an investment, we are going to earn certain amount on it because there will be certain interest on the invested amount. Now, once the time will proceed, then there will be some interest earned, so we need to know that what should be the equal amount which can be taken so that as the time progresses, the capital plus the interest earned on that capital can be all together utilized completely. So its cash flow diagram will be drawn like this

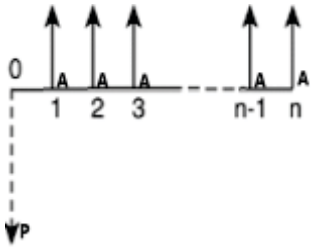

Fig. 3. Equal Payment Series Capital Recovery Factor Cash Flow

So, this is the factor when multiplied with present value 'P' will give us equal annual amount, i.e. , annuities 'A'. It is represented by the symbol

(A/P, I, n)

This is known as Equal Payment Series Capital Recovery Factor, i.e.,

Px(A/P, I, n)

We know,

$$A = F. \frac{i}{(1+i)^n - 1}$$

We further know,

$$F = P\,(1+i)^n$$

So, if this 'F' is replaced with this above expression, then it will be equal to

$$A = P. \frac{i(1+i)^n}{(1+i)^n - 1}$$

So, what we see is that when 'P' is multiplied with this factor will give us 'A'. So, this factor is known as Equal Payment Series Capital Recovery Factor. So,

$$(A/P, I, n) = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Linear Gradient Series Cash Flow: In this type of transaction, if we have received some amount as a loan and we had started repaying it, then every time we will be having some increase in the payment by a fixed quantity. In this series, it is not necessary that we are always increasing but in some cases, we can also decrease.

Geometric Gradient Series Cash Flow: In this type of transaction, if we have received some amount as a loan and we had started repaying it, then every year we will be having some increase in the payment by a fixed percentage. They do not have linear profile but basically they have some parabolic type of profile. In this case also, again the purpose will be to represent this or to find this so that we ultimately find the equivalent uniform cash flow series or the future value or the current value of that cash flow.

Results and Discussion:

We have considered a present sum of Rs.1,00,000 for a time period of 2 years and will compare which mode of investment (i.e., Single Payment, Equal Payment or Capital Recovery) is best for the consumers.

Table 1. Personal Loan Interest Rates of different banks

Name of the Bank	Interest Rate
State Bank of India	9.60% p.a.
ICICI Bank	10.5% p.a.
HDFC Bank	10.5% p.a.
Kotak Mahindra Bank	10.25% p.a.
Axis Bank	12% p.a.

The comparison of best investment for the Personal Loans of different banks is given in the Table 2.

Table 2. Comparison of Best Investment for Personal Loans

Name of the Bank	Single Payment (F/P, i, n)	Equal Payment (F/A, i, n)	Capital Recovery (A/P, I, n)	Best Mode
State Bank of India	120122	104800	114620	Equal Payment
ICICI Bank	122103	105250	116012	Equal Payment
HDFC Bank	122103	105250	116012	Equal Payment
Kotak Mahindra Bank	121557	105125	115624	Equal Payment
Axis Bank	125440	106000	118340	Equal Payment

The above table shows that Equal Payment is the best choice if we are looking for best offers in taking loans.

Different Savings Account interest rates of different banks are given in the Table 3.

Table 3. Savings Account Interest Rates for different banks

Name of the Bank	Interest Rate
State Bank of India	2.75% p.a.
ICICI Bank	3.00% p.a.
HDFC Bank	3.00% p.a.
Kotak Mahindra Bank	3.50% p.a.
Axis Bank	3.00% p.a.

The comparison of best investment for the Savings Account of different banks is given in the Table 4.

Table 4. Comparison of Best Investment for Savings Account

Name of the Bank	Single Payment (F/P, i, n)	Equal Payment (F/A, i, n)	Capital Recovery (A/P, I, n)	Best Mode
State Bank of India	105576	101375	104144	Single Payment
ICICI Bank	106090	101500	104522	Single Payment
HDFC Bank	106090	101500	104522	Single Payment
Kotak Mahindra Bank	107122	101750	105280	Single Payment
Axis Bank	106090	101500	104522	Single Payment

From the above table, we see that Single Payment mode is the best choice in case of Savings Account.

Different Fixed Deposits interest rates of different banks are given in the Table 5.

Table 5. Fixed Deposits Interest Rates of Different Banks

Name of the Bank	Interest Rate
State Bank of India	2.90% p.a.
ICICI Bank	3.00% p.a.
HDFC Bank	3.00% p.a.
Kotak Mahindra Bank	2.50% p.a.
Axis Bank	3.00% p.a.

The comparison of best investment for the Fixed Deposits of different banks is given in the Table 6.

Table 6. Comparison of Best Investment for Fixed Deposits

Name of the Bank	Single Payment (F/P, i, n)	Equal Payment (F/A, i, n)	Capital Recovery (A/P, I, n)	Best Mode
State Bank of India	105884	101450	104370	Single Payment
ICICI Bank	106090	101500	104522	Single Payment
HDFC Bank	106090	101500	104522	Single Payment
Kotak Mahindra Bank	105062	101250	103766	Single Payment
Axis Bank	106090	101500	104522	Single Payment

From the above table, we see that Single Payment mode is the best choice in case of Fixed Deposits.

Different Recurring Deposits interest rates of different banks are given in the Table 7.

Table 7: Recurring Deposits Interest Rates of Different Banks

Name of the Bank	Interest Rate
State Bank of India	4.40% p.a.
ICICI Bank	3.50% p.a.
HDFC Bank	4.40% p.a.
Kotak Mahindra Bank	4.30% p.a.
Axis Bank	4.40% p.a.

The comparison of best investment for the Fixed Deposits of different banks is given in the Table 8.

Table 8. Comparison of Best Investment for Fixed Deposits

Name of the Bank	Single Payment (F/P, i, n)	Equal Payment (F/A, i, n)	Capital Recovery (A/P, I, n)	Best Mode
State Bank of India	108994	102200	106648	Single Payment
ICICI Bank	107122	101750	105220	Single Payment
HDFC Bank	108994	102200	106648	Single Payment
Kotak Mahindra Bank	108785	102150	106496	Single Payment
Axis Bank	108994	102200	106648	Single Payment

From the above table, we see that Single Payment mode is the best choice in case of Recurring Deposits.

Conclusion:

From the above tables, we noticed that different banks offer us different interest rates and we are acquainted with the fact how these rates affect our financial status. When interest rates are high in the case of personal loans, it costs us more while we get paid more in case of high interest rates in Savings Account. It was made clear in the above results which mode of investment is most beneficial for us. In the case of Personal Loans, Equal Payment should be our choice and the bank which provide us best offer is "**State Bank of India**". Again, in the case of Savings Account, Single Payment is the best mode and "**Kotak Mahindra**" provide us the best resources. Similarly in case of Fixed Deposit, again Single Payment is the best mode and the banks which proffer us the best are "**ICICI Bank**", "**HDFC Bank**" and "**Axis Bank**". Lastly, in the case of Recurring Deposits, again Single Payment is the best mode and the banks which proffer us the best are "**ICICI Bank**", "**HDFC Bank**" and "**Axis Bank**". Obtained results are consistent with the present status of these banks.

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