Rate of interest on term deposits– A micro level study*

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Abstract

Public savings in the Banking System are of prime importance to dictate the economy of India. A major component of such savings is through Time deposits constituting nearly 85% of the Total deposits. Furthermore, Term deposits constitute a major component of such Time deposits. Considering all scheduled commercial banks of India, Time deposits are in the order of Rs. 830,000 crores and are growing at more than 17% every financial year. The interest amount paid on the Time deposits directly depends not only on the rate of interest applicable to such deposits but also on a number of other factors, including the method used to calculate the same**.** Though there has been a lot of discussion in the literature on the quantum of the rate of interest, there appear to be no discussions on the method of calculating such interests. This could be because it was thought that the method of calculation should have one and only one meaning. In this paper, we discuss the relationship between the rate of interest and the interest amount. We give several different methods of calculating the interest amount. Although not an exhaustive list, the methods of calculating interest described here are some of the more common methods in use. They indicate that the method of interest calculation can substantially affect the amount of interest paid, and that depositors should be aware not only of nominal interest rates but also of how nominal rates are used in calculating total interest amount. Moreover, since the depositors constitute 89% of bank customers, in the interest of customer protection as also to bring about meaningful competition we observe that it is necessary to have a greater degree of transparency in regards to effective interest rates for depositors.

1. Introduction

Individuals borrow for various purposes using products like home loans, car loans, credit cards, etc. Similarly, there are many examples of lending by individuals that are more commonly thought of as investments. For example, by opening a savings account, an individual makes a loan to the bank; by purchasing a government bond, an individual makes a loan to the government, etc. Just like individuals buy or sell goods and services at a price, the use or extension of credit also has a price attached to it, which is the interest paid or earned. As consumers are able to shop for the best price on a particular

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item of merchandise, the consumers for credit- both borrowers and lenders, should also be able to compare and shop from among the available products. However, comparing the prices for credit can, at times, be confusing. Though rate of interest is generally taken as the price of credit, the amount of interest paid or earned depends on a number of other factors: the amount lent or borrowed, the length of time involved, the stated (or nominal) annual rate of interest, the interest payment schedule, and the method used to calculate interest.

In the Indian banking system though there has been a lot of discussion in the literature on the quantum of the rate of interest, there appear to be no discussions on the method of calculating such interests. This could be because it was thought that the method of calculation should have one and only one meaning. Reserve Bank of India (RBI), through one of its directions, has made it mandatory for the banks to issue Term deposit receipts indicating therein full details, such as, date of issue, period of deposit, due date, applicable rate of interest, etc. In this directive it is however not explicitly mentioned to declare the interest amount or the method of calculating the same. It has been observed that as there are no directions on the method of computing interest, different banks give different interest amounts on given principal kept with them for same period at same rate of interest and with same periodicity of compounding. By adopting different methods of calculating interest, the banks are not violating any RBI directive, as there is no directive (policy) to this effect.

While the economy has moved towards freeing banks to decide their own rates of interest, one may ask why in this paper are we talking about the need for directions on the method of calculating the same. It is felt that by letting the banks follow different methods of calculating interest, no competitive spirit is being inculcated that can be called healthy. On the contrary, it is felt that while in accordance with Sections 21 and 35A of Banking Regulations Act, 1949, there is a master directive on rate of interest, there is also a need to have a direction on the explicit method(s) of computing interest on Term deposits. This will facilitate the consumers in comparing various interest-bearing deposit accounts offered by different banks. The above would be in the interest of public and they will get same returns from all the banks offering the same rate of interest and same periodicity of compounding. Furthermore, this will make the practices of banks uniform and will prevent the conduct of banks detrimental to the interest of the depositors.

All the mandatory / statutory guidelines in respect of deposit accounts are issued to commercial banks by the RBI, the Central Banking Authority of India under powers conferred to it under Sections 21 and 35A of the Banking Regulations Act, 1949. RBI has come out with two recent updates on (1) directive on interest rates on rupee deposits held in Domestic, Ordinary Non-Resident, Non-Resident Special Rupee and Non-Resident (External) Accounts and (2) directive on interest rates on deposits held in FCNR (Banks) Accounts.

In USA two Federal Reserve laws have been passed to minimize some of the confusion consumers face when they borrow or lend money. The Truth in Lending Act, passed in

1968, has made it easier for consumers to comparison shop when they borrow money. Similarly, the purpose of the Truth in Savings Act, passed in 1991, is to assist consumers in comparing deposit accounts offered by depository institutions. Provisions of the Truth in Lending Act have been implemented through the Federal Reserve's Regulation Z, which defines creditor responsibilities. Most importantly, creditors are required to disclose both the Annual Percentage Rate (APR) and the total dollar Finance Charge to the borrowing consumer. The APR is the relative cost of credit expressed in percentage terms on the basis of one year. Just as "unit pricing" gives the consumer a basis for comparing prices of different-sized packages of the same product, the APR enables the consumer to compare the prices of different loans regardless of the amount, maturity, or other terms. Similarly, provisions of the Truth in Savings Act were implemented through the Federal Reserve's Regulation DD, effective June 1993. These provisions include a requirement that depository institutions disclose an Annual Percentage Yield (APY) for interest-bearing deposit accounts. Like the APR, an APY will provide a uniform basis for comparison by indication, in percentage terms on the basis of one year, how much interest a consumer receives on a deposit account. While in USA federal laws make it easier to comparison shop for credit and deposit accounts, a variety of methods continue to be used in India to calculate the amount of interest paid or earned by a consumer. To make an informed decision, it is useful to understand the relationships between these different methods.

A fundamental issue

Public savings in the Banking System are of prime importance to dictate the economy of India. A major component of such savings is through Time deposits constituting nearly 85% of the Total deposits. Furthermore, Domestic (Resident) and Non-Resident Term deposits constitute a major component of such Time deposits. Considering all scheduled commercial banks of India, Time deposits are in the order of Rs. 830,000 crores and are growing at more than 17% every financial year (see Table-1). It may be of interest to note that individuals hold about three-fourths of the Total deposits.

In this note we mostly concentrate on deposit accounts since 89% of bank customers are depositors (for details, one may refer to Tables 1.3 and 1.4 of Basic Statistical Returns of Scheduled Commercial Banks - March 2001). We seek the interpretation of the meaning of "an annum" and "a year" in the declared Term deposit interest rates, which the banks announce. As mentioned earlier, there appears to be no guidelines issued to the banks as to how to compute **simple** interest on Rs. 100/- kept for one year at, say, 9% per annum. This could lead to different banks arriving at different interest amounts resulting from use of different methods for computing simple interest. In other words, looking from depositors' concern, one bank pays Rs. 9/- as simple interest where as another pays Rs. 8.97/- at the end of one year (for a Rs. 100/- deposit kept for one year at 9% per annum). Note that 9% per annum when specified by a bank (with respect to Term deposits) has one and only one meaning as understood in general. So there need to be a one-to-one correspondence between the terms "9% per annum" and the simple interest computed for one year. Moreover, compound interest can be computed only when we know how to compute simple interest. This is so since the various methods used to calculate interest are basically variations of the simple interest calculation method. The basic concept underlying simple interest is that interest is paid only on the original amount deposited for the length of time the depositor keeps the funds with the bank. The amount deposited is referred to as the principal. In the simple interest calculation, interest is computed only on the portion of the original principal. When the compound interest calculation is used, interest is calculated on the original principal plus all interest accrued to that point in time. Since interest is paid on interest as well as on the amount deposited, the effective interest rate is greater than the nominal interest rate. The compound interest method is often used by banks and savings institutions in determining interest they pay on savings and Term deposits "loaned" to the institutions by the depositors. We use the terms simple interest and nominal interest analogously.

We now give the following example that motivates us into the problem.

Example

Consider a domestic Term deposit of Rs. 10,000/- made for 364 days (i.e., 1 day less than a full year) with start date May 1, 2002 and end date April 29, 2003. The period May 1, 2002 – April 29, 2003 (both the bordering days included) earns interest at 8% per annum with quarterly compounding. What should be the maturity amount on April 30, 2003?
Do we have options? The answer happens to be in the affirmative. Moreover there are several options. The maturity amounts for six different options are worked out below.

Option 1: **10000*(1+8/400)^4 – 10000*(1+8/400)^3*8/36500 = Rs. 10822.00**

Option 2: **10000*(1 + 8/400)^3*(1 + 8*88/36500) = Rs. 10816.76**

Option 3: **10000*(1 + 8/400)^3*(1 + 8*2/1200 + 8*29/36500) = Rs. 10821.03**

Option 4: **10000*(1 + 8*92/36500)^3*(1 + 8*88/36500) = Rs. 10821.99**

Option 5: **10000*(1 + 8*90/36000)^3*(1 + 8*60/36000 + 8*29/36000) = Rs. 10821.96**

Option 6: **10000*(1 + 8/400)^(364/91.25) = 10000*(1 + 8/400)^3*(1 + 8/400)^(90.25/91.25) = Rs. 10821.97**

Note that a complete year beginning May 1, 2002 has 1^{st}, 2^{nd}, 3^{rd} and 4^{th} quarters with 92, 92, 92 and 89 days respectively. In Option 1 one day's interest, based on the new principal at the beginning of the forth quarter, is subtracted from the maturity amount worked out for the full year. In Option 2 the amount is first worked out for three quarters and then interest for 88 days, based on the new principal at the beginning of the forth quarter, is added. In Option 3 the amount is first worked out for three quarters and then interest for 2 months and 29 days, based on the new principal at the beginning of the forth quarter, is added. In Option 4 the amount is first worked out for three quarters (based on the actual number of days in the quarters) and then interest for 88 days, based on the new principal at the beginning of the forth quarter, is added. In Option 5 the amount is first worked out for three quarters (based on the 30 days a month and 360 days a year) and then interest for 2 months and 29 days (of a 30 days month and 360 days year), based on the new principal at the beginning of the forth quarter, is added. Finally, in Option 6 the amount is worked out using a close approximation of the compound interest formula, i.e., p*(1+91.25*r/36500)^(d/91.25). Here p is the principal, r the percentage rate of interest and d the number of days in the deposit period. Also, compounding is done after every 365/4=91.25 days. Options 1 and 4 give almost the same answer. However, Option 2 seems to be giving less interest.

Which of the above options could be considered as fair and reasonable? If asked to pick one which Option would you consider as the most appropriate, logical, fair and reasonable answer?

The above discussions lead to some fundamental questions: What is meant by the **rate of interest** on Term deposit accounts? Is there any relationship between such an interest rate and the absolute simple interest? Further, what is the concept of quarterly compounding? Depending on how these vital questions are answered, its impact on scheduled commercial banks could be in crores of rupees in some financial years.

Other questions related to Term deposits that may be of interest to the public and banks are:

- Is “annum” and “year” the same? Does four quarters make an annum or 365 days make an annum?

- Does rate of interest, say, x% per annum mean (x/12)% per month or (x/365)% per day?

- Can we assume a “year” to mean the period that stretches from any start date in a calendar year to one day before the same date in the next calendar year?

- How do we define a quarter? What is the interpretation of the phrase “interest paid quarterly”? How is it related to an annum or a year or a month? Can we assume a “quarter” to mean the period that stretches from any start date in a calendar year to one day before the same date after three calendar months?

- How do we define a month? Is it correct to interpret a “month” as the period that stretches from any start date in a calendar month to one day before the same date in the next month? This, if correct, would be a generalized definition of a month.

The above terms do not seem to have a formal definition. It seems that the need to define the above terms has not yet been felt. This has led to different banks interpreting these terms in their own way and thereby adopting different methods of interest computation. Furthermore, this results in different yields on maturity for a given principal at the same rate of interest and same periodicity of compounding. To eliminate the possibility of any type of unjust practices (knowingly or unknowingly followed by the banks) for calculation of interest it is necessary to streamline the method of interest calculation. A suggestion towards this end is given in this paper.

With the advent of computerized work environment and innovative financial products brought out by various banks, the techniques of accounting needs to be re-looked into. Das, Das and Das (1999) carried out a micro level study on some recent innovative banking services. They spelt out that, with the newly emerging financial products, there is a need for proper definitions in order to carry out micro level financial accounting.

In this paper, we give various methods used for computing interest. Although not an exhaustive list, the methods of calculating interest described here are some of the more common methods in use. They indicate that the method of interest calculation can substantially affect the amount of interest paid, and that depositors should be aware not only of nominal interest rates but also of how nominal rates are used in calculating total interest amount. The same applies to borrowers or bank lending.

Through time, the level of interest rates may fluctuate, but the method of calculation remains constant. Thus, the concepts of figuring interest, explained in this paper, apply regardless of whether the specific numerical examples used are representative of today's market rates.

Table-1: Deposit Growth Rate from 1993 to 2001

(Rs. Crore)

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total Deposits	274938	323632	386859	429003	499763	598485	714025	851593	989141
Annual % Growth	--	*18*	*20*	*11*	*16*	*20*	*19*	*19*	*16*
Demand Deposits	49541	60700	76903	80614	90610	102513	117423	145283	159407
Annual % Growth	--	*23*	*27*	*5*	*12*	*13*	*15*	*24*	*10*
% of Total Deposit	**18**	**19**	**20**	**19**	**18**	**17**	**16**	**17**	**16**
Time Deposits	225397	262932	309956	348389	409153	495972	596602	706310	829734
Annual % Growth	--	*17*	*18*	*12*	*17*	*21*	*20*	*18*	*17*
% of Total Deposit	**82**	**81**	**80**	**81**	**82**	**83**	**84**	**83**	**84**

Source: Basic Statistical Returns of Scheduled Commercial Banks - March 2001 (Vol. 30) – Table 1.1

2. How to compute simple interest – some methods

Based on some of the points in Section 1, we now suggest methods (through an illustration) of computing simple interest. In our illustration, though we have taken quarterly compounding, the simple interest method is inherent in it. We consider a specific example to illustrate the various methods that may be adopted to compute interest. The methods are compared to understand their impact. These are discussed later in Section 3. Though the whole exercise is based on only one example, as below, it highlight sufficiently well that there is a need for streamlining the accounting procedures.

Illustration

A Term deposit with a principal amount of Rs. 10,000/-, at a declared rate of interest of 10% per annum, compounded quarterly, during the period March 1, 2000 to February 28, 2001 (both days inclusive), i.e., for a full year. (Note that year 2000 is a leap year)

Method 1 (Method of days through calendar year splitting)

Interest at end of 1st quarter (on June 1, 2000) – 10000*.1*92/**366** = 251.37
Interest at end of 2nd quarter (on September 1, 2000) – 10251.37*.1*92/**366** = 257.68
Interest at end of 3rd quarter (on December 1, 2000) – 10509.05*.1*91/**366** = 261.29
Interest at end of 4th quarter (on March 1, 2001) – 10770.34*.1*(31/**366**+59/**365)** = 265.32
Maturity amount = 11035.66

Observations:

a) Total Number of days in the four quarters add up to 92+92+91+90 = 365.
b) Percentage Yield = (maturity amount/principal - 1)*100 = 10.3566.
c) The above analogy may imply that the simple interest for the year is equal to 10000*0.1*(306/366+59/365) = 997.71 or the actual rate of simple interest is 9.9771% rather than the declared 10%.
d) For this specific example the method is not public friendly.
e) With increasing deposits scenario this method is profitable to banks.
f) The method is very scientific but has the drawback of having only 365 days in the four quarters of the specified period, though part of it belongs to a leap year.
g) The date February 29 plays a crucial role. For this specific example the period of deposit does not contain February 29.
h) According to the Truth in Savings Act (1991) of the Federal Reserve, for the deposits held in the banks of USA, a daily rate of 1/366 of the interest rate for 366 days in a leap year may be applied only if the deposit will earn interest for February 29. Thus for the US banks this method may be in violation of the Regulation DD of the Federal Reserve.
i) The method also lead to situations where there are 366 days in the four quarters and part of the period belongs to a non-leap year. For example, unlike the period of deposit in the illustration, if the period of deposit is March 1, 2003 to February 29, 2004, the simple interest for the year is equal to 10000*0.1*(306/365+60/366) = 1002.29 or the actual rate of simple interest is 10.0229% rather than the declared 10%.

Method 2 (Method of actual days)

Interest at end of 1st quarter (on June 1, 2000) – 10000*.1*92/**365** = 252.05
Interest at end of 2nd quarter (on September 1, 2000) – 10252.05*.1*92/**365** = 258.41
Interest at end of 3rd quarter (on December 1, 2000) – 10510.46*.1*91/**365** = 262.04
Interest at end of 4th quarter (on March 1, 2001) – 10772.50*.1*90/**365** = 265.62
Maturity amount = 11038.13

Observations:

a) Percentage Yield = 10.3813
b) The method is based on the actual number of days in the specified year (period of deposit). Thus in situations where the specified period contains the leap day

(February 29), the dividing factor would be 366 instead of 365. However, if a year is reckoned as consisting of 365 days, for computation of interest, then the dividing factor would always remain 365 (even for periods within a leap year).

c) The simple interest for the year is = 10000*0.1*(365/365) = 1000 or the rate of simple interest is 10% as it should be.

d) The method is accurate and exact.

e) According to the Truth in Savings Act (1991) of the Federal Reserve, if February 29 is present in the term of the deposit a daily rate of 1/366 or 1/365 of the interest rate for 366 days in a leap year may be applied.

f) In case the period of deposit does not contain any day of a leap year then both the Methods 1 and 2 are equivalent.

g) The elegance of Methods 1 and 2 is in its taking actual number of days in the quarters rather than considering every quarter as containing 365/4 = 91.25 days.

<u>Method 3</u> (Classical method)

Maturity amount = 10000*(1+10/400)^4 = 11038.13

Observations:

a) Percentage Yield = 10.3813

b) The method works fine as long as the unit of compounding is a fraction of the year and the specified period is a multiple of such a fraction.

c) The method is not friendly in the present scenario where the period of deposit has a broken period.

d) Though the compound interest formula holds only where the exponent in an integer, a close approximation of the compound interest formula (by use of the non-integral exponent) is given by: A1 = p*(1+r/400)^(d/91.25) where p is the principal, r the percentage rate of interest, d the number of days in the deposit period and A1 the maturity amount. Also, compounding is done after every 365/4=91.25 days of the year; a year being reckoned as consisting of 365 days. Let d = 91.25*m + y where m is an integer and y a real such that m ≥ 0 and 0 ≤ y < 91.25. Then, alternately we can write A1 = p*(1+r/400)^m*(1+r/400)^(y/91.25). For 0 < x < 1, 0 < a < 1, recalling the expansion of (1+x)^a, it follows that (1+x)^a < 1+ax. Therefore, A1 = p*(1+r/400)^m*(1+r/400)^(y/91.25) < p*(1+r/400)^m*(1+y*r/36500) = A, say. Note that under the conditions (i) a year is reckoned as consisting of 365 days and (ii) compounding is done after every 365/4=91.25 days, the exact maturity interest amount is actually A. The difference between A and A1 is maximum when y = 91.25/2.

<u>Method 4</u> (Method of quarters and days)

This is the method given by Indian Banks' Association and approved by RBI, which is a combination of Method 3 (for full quarters) and Method 2 (for incomplete quarters based on exclusive 365 days). An abstract of the method is presented below. However, for details one may refer to the IBA Code for Banking Practice.

(i) Interest on deposits for fixed term may be paid, credited, transferred or reinvested with frequency not less than the quarterly rests. However, payment of monthly interest may be allowed, if required, by discounting the quarterly interest accrued.

(ii) Interest on deposits where the terminal period (month / quarter etc., as the case may be) is incomplete shall be paid on maturity.

(iii) On deposits repayable in less than three months or where the terminal quarter is incomplete, interest would be paid for the actual number of days on the basis of 365 days in a year.

Interest at end of 1st quarter (on June 1, 2000) – 10000*.1*1/4 = 250.00
Interest at end of 2nd quarter (on September 1, 2000) – 10250.00*.1*1/4 = 256.25
Interest at end of 3rd quarter (on December 1, 2000) – 10506.25*.1*1/4 = 262.66
Interest at end of 4th quarter (on March 1, 2001) – 10768.91*.1*1/4 = 269.22
Maturity amount = 11038.13

Observations:

a) Percentage Yield = 10.3813

b) In its present form the method may not be unbiased for interest computation in all situations. The method depends on how a quarter is defined. Due to the method being based on a mixture of quarters and days, it induces a bias.

c) For interest computation the method assumes that all quarters are of identical size (i.e., 365/4=91.25 days) as it gives equal fraction (i.e., 91.25/365=1/4) of interest for each quarter.

d) Consider a deposit of 364 days not involving February 29 (i.e., one day less than a full year consisting of four quarters or 365 days) made on any day of a calendar year. Such a deposit involves three full quarters. The number of days, X, in the terminal partial quarter would have the following probability distribution:

X=88, 89, 90, 91;
P(X=88) = 29/365; P(X=89) = 62/365; P(X=90) = 63/365; P(X=91) = 211/365.

For X days in the terminal partial quarter the interest would be based on X/365 times rate of interest. In other words, interest is not given for (91.25-X) days. The expected number of days in the terminal partial quarter is
E(X)=(88*29+89*62+90*63+91*211)/365=90.2493.
This implies that, the expected number of days for which interest is not given is E(91.25-X)=91.25-E(X)=1.000685.

e) From the argument in (d) above, it follows that by making a deposit for one day less than a full year the depositor would lose interest for more than a day in 42% of the cases:

1. the probability of not getting interest for 3.25 days of the year is 0.08
2. the probability of not getting interest for 2.25 days of the year is 0.17
3. the probability of not getting interest for 1.25 days of the year is 0.17
4. the probability of not getting interest for more than two days of the year is 0.25
5. the probability of not getting interest for more than one day of the year is 0.42

f) To generalize, consider the situation where a deposit is made for (365-k) days, k ≥ 1, such that it involves three full quarters. The number of days, X, in the terminal partial quarter would have the following probability distribution:

X=89-k, 90-k, 91-k, 92-k;
$P(X=89-k) = 29/365$; $P(X=90-k) = 62/365$; $P(X=91-k) = 63/365$; $P(X=92-k) = 211/365$.

The expected number of days in the terminal partial quarter is
$E(X)=((89-k)*29+(90-k)*62+(91-k)*63+(92-k)*211)/365=91.2493-k$.
This implies that, the expected number of days for which interest is not given is $E(91.25-X)=91.25-E(X)=0.000685+k$. Generalizing argument of (e) above, it follows that by making a deposit for k day less than a full year:

1. the probability of not getting interest for (k+2.25) days of the year is 0.08
2. the probability of not getting interest for (k+1.25) days of the year is 0.17
3. the probability of not getting interest for (k+0.25) days of the year is 0.17
4. the probability of not getting interest for more than k+1 days of the year is 0.25
5. the probability of not getting interest for more than k day of the year is 0.42

g) Generalization of (f) above to any deposit of 92 days or more leads to the following three cases.

Case (1): Starting a deposit on any day of a calendar year, the number of days, X_1, in one quarter (i.e., 3 months not involving February 29) would have the following probability distribution:

X_1=89, 90, 91, 92;
$P(X_1=89) = 28/365$; $P(X_1=90) = 62/365$; $P(X_1=91) = 61/365$; $P(X_1=92) = 214/365$.

The expected number of days in one quarter is
$E(X_1)=(89*28+90*62+91*61+92*214)/365=91.2630$.
A 3 months period has 92 days with probability 0.5863. Thus, in 59% of the deposits made for 3 months or more but less than 6 months, a depositor gets interest for 0.75 days less. A deposit made for 91+t days, $t \geq 1$, such that it is less than 2 quarters receives on an average interest for {(91+t) - 0.0130} days.

Case (2): Starting a deposit on any day of a calendar year, the number of days, X_2, in two quarters (i.e., 6 months not involving February 29) would have the following probability distribution:

X_2=181, 182, 183, 184;
$P(X_2=181) = 119/365$; $P(X_2=182) = 63/365$; $P(X_2=183) = 61/365$; $P(X_2=184) = 122/365$.

The expected number of days in two quarters is
$E(X_2)=(181*119+182*63+183*61+184*122)/365=182.5096$.

A 6 months period has 183 and 184 days with respective probabilities 0.1671 and 0.3342. In other words the period has 183 or 184 days with probability 0.5014. Thus, a depositor gets interest for

(1) 1.5 days less in 33% of the deposits made for 6 months or more but less than 9 months,
(2) 0.5 days less in 17% of the deposits made for 6 months or more but less than 9 months.

A deposit made for 182+t days, $t \geq 1$, such that it is less than 3 quarters receives on an average interest for {(182+t) - 0.0096} days.

Case (3): Starting a deposit on any day of a calendar year, the number of days, X_3, in three quarters (i.e., 9 months not involving February 29) would have the following probability distribution:

X_3=273, 274, 275, 276;
$P(X_3=273) = 211/365$; $P(X_3=274) = 63/365$; $P(X_3=275) = 62/365$; $P(X_3=276) = 29/365$.

The expected number of days in three quarters is
$E(X_3)=(273*211+274*63+275*62+276*29)/365=273.7507$.
A 9 months period has 274, 275 and 276 days with respective probabilities 0.1726, 0.1699 and 0.0795. In other words the period has 274, 275 or 276 days with probability 0.4219. Thus, a depositor gets interest for

(1) 2.25 days less in 8% of the deposits made for 9 months or more but less than a year,
(2) 1.25 days less in 17% of the deposits made for 9 months or more but less than a year,
(3) 0.25 days less in 17% of the deposits made for 9 months or more but less than a year.

A deposit made for 273+t days, $t \geq 1$, such that it is less than 4 quarters receives on an average interest for {(273+t) - 0.0007} days.

h) In situations where starting a deposit on any day of a calendar year involving February 29 (i) in that year or (ii) in the subsequent year, the number of days, X_1, X_2 and X_3, in one, two and three quarters respectively, has a probability distribution that would lead us to the following:

(1) A deposit made for 91+t days, $t \geq 1$, such that it is less than 2 quarters receives on an average interest for (i) {(91+t) - 0.1708} days or (ii) {(91+t) - 0.1007} days.
(2) A deposit made for 182+t days, $t \geq 1$, such that it is less than 3 quarters receives on an average interest for (i) {(182+t) - 0.1694} days or (ii) {(182+t) - 0.3493} days.
(3) A deposit made for 273+t days, $t \geq 1$, such that it is less than 4 quarters receives on an average interest for (i) {(273+t) - 0.1626} days or (ii) {(273+t) - 0.5925} days.

The discussions (g) and (h) above lead us to the following theorem.

THEOREM 1: Under the assumption that (i) interest is declared on a per annum basis, (ii) an annum is reckoned as 365 days, and (iii) there is equal chance of a deposit starting on any day of a calendar year, the following hold:
The Method 4 (IBA method of quarters and days) for interest computation on domestic Term deposits of 92 days or more is on the average biased unfavourably towards depositors in terms of interest payoffs.

i) Given the relevant parameters, is it true that compound interest gives higher returns than simple interest in all situations? Contrary to general belief, we show that if we use the method suggested by IBA, i.e. the Method 4, the answer is a "No". Using the results of observation (g) we consider two situations.

A. Deposit for one quarter or more but less then two quarters. Consider a deposit falling in the 59% category of the first quarter being of 92 days. A deposit is kept for 92+d days such that $d \geq 0$ and 92+d days is less than two quarters. Now we take the following two cases.

Case 1: Simple interest (or equivalently, interest on deposit is compounded quarterly if the tenure is greater than or equal to two quarters).
Case 2: Interest on deposit is compounded quarterly.

Let Int1 and Int2 be the interest amount for Cases 1 and 2 respectively. Denoting the principal amount by p and the percentage rate of interest per annum by r, we have

$$\text{Int1} = pr(92+d)/36500 \text{ and } \text{Int2} = p\{(1+r/400)(1+rd/36500)-1\}.$$

$$\text{Therefore, Int2} - \text{Int1} = pr(rd-300)/(36500*400).$$

Thus, it follows that, using Method 4, compounding quarterly give less returns than simple interest for a deposit made for a period of 92+d days (92+d days is less than two quarters) provided
(i) the first quarter has 92 days (this happens with probability 0.59) and
(ii) $d < 300/r$.

B. Deposit for two quarters. Consider a deposit falling in the 33% category of the first two quarters being of 184 days. A deposit is kept for such a period of 184 days. Now for the deposit take the following two cases.

Case 3: Simple interest.
Case 4: Interest compounded quarterly.

Let Int3 and Int4 be the interest amount for Cases 3 and 4 respectively. Then, we have

Int3 = pr(184)/36500 and Int4 = p{(1+r/400)^2-1}

Therefore, Int4 – Int3 = pr(73r-480)/(29200*400)

Thus we have, using Method 4, compounding quarterly give less returns than simple interest for a deposit made for a period of 184 days provided
(i) the first two quarters have a total of 184 days (this happens with probability 0.33) and
(ii) r < 480/73 = 6.5753.

The discussions in (i) lead us to the following theorem.

THEOREM 2: Under the assumption that (i) interest is declared on a per annum basis, (ii) an annum is reckoned as 365 days, and (iii) there is equal chance of a deposit starting on any day of a calendar year, the following hold:
Using Method 4 (IBA method of quarters and days) for interest computation on domestic Term deposits with r being the percentage rate of interest per annum,
(1) compounding quarterly give less returns than simple interest for a deposit made for a period of 92+d days (92+d days is less than two quarters) provided
(i) the first quarter has 92 days (this happens with probability 0.59) and
(ii) 0 ≤ d < 300/r,
(2) compounding quarterly give less returns than simple interest for a deposit made for a period of 184 days provided
(i) the first two quarters have a total of 184 days (this happens with probability 0.33) and
(ii) r < 480/73 = 6.5753.

Method 5 (Method of calendar quarters through calendar year splitting)
Interest at end of 1st partial calendar quarter (on April 1, 2000) – 10000*.1*31/**365** = 84.93
Interest at end of 2nd calendar quarter (on July 1, 2000) – 10084.93*.1*1/4 = 252.12
Interest at end of 3rd calendar quarter (on October 1, 2000) – 10337.05*.1*1/4 = 258.43
Interest at end of 4th calendar quarter (on January 1, 2001) – 10595.48*.1*1/4 = 264.89
Interest at end of 5th partial calendar quarter (on March 1, 2001) – 10860.37*.1*59/**365** = 175.55
Maturity amount = 11035.92

Observations:

a) Total Number of days in the partial calendar quarters add up to 31+59 = 90.
b) Percentage Yield = 10.3592.
c) The above analogy may imply that the simple interest for the year is equal to 10000*0.1*(3/4+90/365) = 996.58 or the actual rate of simple interest is 9.9658% rather than the declared 10%.
d) For this specific example the method is not public friendly. However, there would be situations where the actual rate of simple interest is more than 10%.

e) It is interesting to note that this method questions the interpretation of the phrase "interest paid quarterly". In this method interest is paid every calendar quarter.

__Method 6__ (Method of 30 days month and 360 days year)

The method is identical to the Method 4 (IBA Method) for full quarters. However, for the broken period, it considers a calendar month as 30 days, ignoring 31st of a month altogether for interest payment. The year is taken to constitute 360 days.

Interest at end of 1st quarter (on June 1, 2000) – 10000*.1*90/360 = 250.00
Interest at end of 2nd quarter (on September 1, 2000) – 10250.00*.1*90/360 = 256.25
Interest at end of 3rd quarter (on December 1, 2000) – 10506.25*.1*90/360 = 262.66
Interest at end of 4th quarter (on March 1, 2001) – 10768.91*.1*90/360 = 269.22
Maturity amount = 11038.13

Observations:

(a) Percentage Yield = 10.3813

(b) In its present form the method may not be unbiased for interest computation in all situations. The method being based on a mixture of months/quarters and days, it induces a bias by ignoring the actual number of days of the month in the broken period

(c) For interest computation the method assumes that all quarters are of identical size (i.e., 365/4=91.25 days) as it gives equal fraction (i.e., 90/360=91.25/365=1/4) of interest for each quarter.

(d) If a month in the broken period consists of 31 days, then interest is not given for the day falling on 31st of the month. In other words, two deposits with the same principal, same start date and earning the same rate of interest but one maturing on 31st of a month and the other maturing on 1st of the next month would give the same returns.

(e) As long as the broken period does not involve 31st of a month, the method yields more returns than the Method 4 (IBA method). However, in case 31st of a month is involved (and the period February 28 – March 1 is not involved) in the broken period, the method yields less returns than the Method 4 (IBA method).

__Method 7__ (Method for FCNR(B) deposits)

The salient features of the deposit scheme are:

(i) the deposits shall be accepted under the scheme for the following maturity periods— one **year** and above but not more than three **years**,

(ii) the interest on the deposits accepted under the scheme shall be paid on the basis of 360 days to a **year**,

(iii) the interest on deposits shall be calculated and paid in the following manner— (a) for deposits upto one **year**, at the applicable rate without any compounding effect, (b) in respect of deposits for more than one **year**, at intervals of 180 days each and thereafter for remaining actual number of days (with the option to receive the interest on maturity with compounding effect).

Observations:

a) The method is public friendly and in the public interest but is disadvantageous to banks.

b) The method has been adopted as per international practice.

c) There is some confusion on whether the term "year" used in the points (i), (ii) and (iii) above have the same meaning. However, in the spirit of the directive, the following hold: (1) the deposits shall be accepted under the scheme for the following maturity periods— one year (365days / in case February 29 belongs in the period then 366 days) and above but not more than three years; (2) the interest on the deposits accepted under the scheme shall be paid on the basis of 360 days to a year, i.e., rate of interest on the basis of percent per annum/year would mean percent per 360 days; (3) the interest on deposits shall be calculated and paid in the following manner— (a) for deposits upto 360 days, at the applicable rate without any compounding effect, (b) in respect of deposits for more than 360 days, at intervals of 180 days each and thereafter for remaining actual number of days (with the option to receive the interest on maturity with compounding effect).

d) If a deposit (US$ 10,000) is kept for a full calendar year of 365 days at rate of interest say 2% per annum it would lead to a maturity amount 10000*(1+0.02*180/360)^2*(1+0.02*5/360)= US$ 10203.83. Thus interest is calculated / paid at two intervals of 180 days each plus for 5 days.

e) Months do not play any role in the above interest computations.

f) An alternate way to compute the interest may lead to a maturity amount 10000*(1+0.02/2)^(365/180)=10000*(1+0.02/2)^(360/180)*(1+0.02/2)^(5/180)= US$ 10203.82. Here, from theoretical considerations, the compound interest formula has been used by simply generalizing for situations where the exponent may be non-integral. This gives an approximate result (see discussion in observation (d) of Method 3). However, actually the compound interest formula holds only where the exponent in a positive integer. Thus the correct formula is as indicated in (d) above and would lead to a maturity amount of US$ 10203.83. The amount of interest difference is US$ 0.01. This difference in interest, due to use of the non-integral exponent, would increase as we move from a broken period of 5 days and upwards and shall attain a maximum when the broken period is of 90 days.

3. Remarks, impact and conclusion

Apart from Term deposits, which had been the main thrust of this paper, there are other different types of well known financial products and services. In particular, we have the Government securities, bonds and treasury bills. The methodologies adopted in Government securities, bonds, etc. also need to be looked into. For example the interest computations on Government securities are based on the historical 30 days a month and 360 days a year method though at times it necessitates interest computations for one or more day(s). As long as the total period is a multiple of half years it works fine. However, the moment there is a combination of half-year periods and days the method induces bias. This is obvious for securities floated on 31^{st} of a month. The present method may be a worldwide practice. However, if there is a broken period involving days there are some doubts on the correctness of the practice on the grounds that it may be detrimental to the interest of the depositors/investors. Note that (ignoring the existence of a leap year) the interest is declared per annum and annum can either be defined as consisting of 12 hypothetically equal parts (months) or 365 equal parts (days) or 360 days but not a mixture of the above.

In contrast, RBI relief bond works fine since overall it cannot involve day computation of interest since interest is paid for half a year. Half year's interest is well defined and is equal to (principal)*(rate of interest)/200. The only problem that may occur is in the first interest and in the last interest payoffs. However, in case of non-cumulative interest bonds, this is taken care of by making appropriate proportion such that the first interest and last interest add up to give half year's interest.

We need to look into what is or what should be the best business practice.

Difference in Percentage Yield

The difference in method of interest computation affects the Percentage Yield of the deposit. We see in the illustration given in Section 2 that, in terms of the Percentage Yield, Method 1 stands alone where as Methods 2, 3, 4 and 6 behave identically. Let A be the Percentage Yield due to Method 1 and let B be the Percentage Yield due to either of the Methods 2, 3, 4 or 6. The Difference in Percentage Yield = B – A = 0.0247.
Thus, specific to this example, due to a variation in method we have:
Difference in Percentage Yield for an interest rate of 10% per annum = 0.0247.
Difference in Percentage Yield for an interest rate of 7% per annum = 0.0169 (on similar lines).

In terms of the simple (nominal) interest, the analogy implies that the simple interest, under Method 1, for the year is equal to 10000*0.1*(306/366+59/365) = 997.71 or the actual rate of simple interest is 9.9771% rather than the declared 10%. However, under either of the methods 2, 3 or 4, the simple interest for the year is = 10000*0.1*(365/365) = 1000 or the rate of simple interest is 10% as should be. Thus even for a declared simple interest of 10% the difference in the effective nominal rate of interest is 0.0229%.

Impact of difference in Percentage Yield

The above figures would guide us to an estimate of the difference in total amounts of interest that results due to adoption of different methods of interest computation in the financial year 2000-2001. To get a feel of the percentage distribution of Term deposits of banks according to interest rate range, one may refer to Table 1.27 of Basic Statistical Returns of Scheduled Commercial Banks - March 2001.

For a bank with Term deposits totaling Rs. 11,000 crores (during the financial year 2000-2001) at an average rate of interest of 7% per annum has a difference in total amounts of interest = Rs. 110000,000,000*0.000169 = Rs. 18,590,000 (Rupees One crore eighty five lacs and ninety thousand). This difference is solely due to different methods adopted for computation of interest on Term deposits. Exact details can be worked out but in general the overall impact would be in crores of rupees.

Alternatively, we may compare Method 5 with Methods 2, 3, 4 and 6. In this case the difference in Percentage Yield is 0.0221. Here too the difference in interest amount will be substantial as in the earlier comparison.

Finally, Method 4, about which lot has been discussed in Section 2, needs to be modified in the light of the fact that the interest is declared per annum and an annum can either be defined as consisting of 12 hypothetically equal parts (called months) or 365 equal parts (days) or 364 days or 360 days **but** not a mixture of them. From a careful look at Tables 1.24 and 1.25 of Basic Statistical Returns of Scheduled Commercial Banks - March 2001, we observe that:

(i) 94.7% of the total number of Term deposit accounts (130563,623) in scheduled commercial banks have period of maturity of 91 days and above.

(ii) 90.3% of the total Term deposit amounts (Rs. 601456,12 Lakh) in scheduled commercial banks have period of maturity of 91 days and above.

Thus, it is easy to figure out the absolute amount of interest paid less for the various cases, as discussed under Method 4, with associated probabilities.

Conclusion

We draw the following inferences from this note:

A. Need for introduction of generalized definitions of year, quarter and month

There is a need for introduction of generalized definitions of year, quarter and month (for maturity patterns) as these definitions affect the interest amounts customers receive from their deposits.

Suggested generalized definitions

1.) A “year” may mean the period that stretches from any **start date** in a calendar year to one day before the **same date** in the next calendar year.
2.) A “quarter” may mean the period that stretches from any **start date** in a calendar month to one day before the **same date** after three calendar months.
3.) A “month” may mean the period that stretches from any **start date** in a calendar month to one day before the **same date** in the next calendar month.

In the definition of a year, if the start date is February 29, a period of one year would stretch till February 28 of the next calendar year.
In the definition of a quarter, in case the same date (as the start date in a calendar month) does not exist after three calendar months then the period in a quarter would stretch till the last day in the following 3rd calendar month.

In the definition of a month, in case the same date (as the start date in a calendar month) does not exist in the next calendar month then the period in a month would stretch till the last day of the next calendar month.

B. Need for introduction of the definition of rate of interest on Term deposits

Historically, in order to simplify interest calculations, lenders and borrowers often assumed that each year had twelve 30-day months, resulting in a 360-day year. For any given nominal rate of interest, the interest paid will be greater when a 360-day year is used in the interest calculation than when a 365-day year is used.

Rate of interest on Term deposits could be based on percent per day. However, this may be translated as rate of interest based on a specified number of days; 364 or 365 days or, as per international standards, 360 days. In other words, interest rates on Term deposits may be based on such a period of 364 (or 365 or 360) days to a year.

Interest when compounded quarterly would result into computation based on the number of days in the quarters. Thus here the number of days in a quarter varies from one quarter to another. However, relaxing constraints, one may consider compounding at fixed number of days like 30 days or 90 days or 91 days or 73 days or 1 day (daily compounding), etc. Note that 30*12=360, 90*4=360, 91*4=364, 73*5=365 and 1*365=365.

Such a method would be able to handle any situation without general bias as envisaged in Method 7 of FCNR(B) deposits. Also it would be friendlier for computer intensive computations. However, in order to formalize all these, further research and thought is required.

In the present scenario of banks having more freedom to decide interest rates on Term deposits, it is felt, keeping in view the development in computing facilities available at bank's disposal, the restriction of compounding periodicity could be relaxed unless there is an economic reason not to do so. At present all interests payable under Rupee deposits are paid at quarterly or longer rests. As a first step towards de-regularizing, in the interest rates on Term deposits and savings account deposits, the compounding periodicity may be relaxed allowing banks to decide the periodicity of compounding. In other words, compounding periodicity may be brought down to monthly or daily compounding. The Central Bank of India has recently suggested a revision in case of advances and loan accounts to charge/compound interest at monthly rests. This is a switch over from interest charge with quarterly or longer rests. (This change became necessary in order to facilitate adoption of 90 days' norm for recognition of loan impairment.) In view of the above and to bring in uniformity there is at least a scope to switch to a 30 day compounding in case of term deposits.

C. Need to address issues related to Yield

There is a need to address issues related to Yield. In this connection we may note item 22(h) of the Master Directive on Interest Rates on Rupee Deposits held in Domestic, Ordinary Non-Resident (NRO), Non-Resident Special Rupee (NRSR) and Non-Resident (External) (NRE) Accounts. Unlike the provisions of the Truth in Savings Act for deposits in USA where there is a requirement that depository institutions disclose an Annual Percentage Yield (APY) for interest-bearing deposit accounts, in India it is prohibited to issue any advertisement / literature soliciting deposits from public highlighting only the compounded Yield on Term deposits without indicating the actual rate of simple interest offered by bank for the particular period. In other words, it appears that the RBI requires that banks invariably indicate the simple rate of interest per annum for the period of deposit. However, additional information on compounded Yield may be indicated but this is not mandatory for banks to declare. In the recently announced annual monetary and credit policy for the year 2002-2003, there is now a proposal that banks should provide information on deposit rates for various maturities and effective annualised return to the depositors.

Banks come out with the Interest Rates sheet for public use so that people see them and then decide how best to allocate their funds into various deposits. Through such a literature (or advertisement) the customer / public is being made aware upfront of the net interest that the bank intends to give through compounding calculation methodology adopted by the bank. This attracts the public to make deposits with the bank. Some of these sheets have additional information on Yield. This Yield would mean something and there would be a definite method to work it out.

It is observed that in the global financial system various terms like “cumulative rates”, “cumulative rates p.a.”, “gross compounded annual return (%)”, “Annual Percentage Yield (APY)”, “Yield p.a.”, “effective annualised return”, “effective annual rate”, “compounded Yield”, “Annual Equivalent Rate (AER)”, etc. are in use.

Unlike clear and detailed definition of APY (as per Federal Reserve) and AER (as per British Bankers’ Association), there is no clear definition of the Yields advertised in the Indian bank scenario. Thus there is a need to answer the question, what is the interpretation of such Yield statements? Thus, Reserve Bank of India needs to introduce a standard definition of Yield to be adopted universally by all banks in India. The declaration of such a standardized Yield figure by all banks would lead to more transparent figures of actual interest rates.

D. Need to address issues relating to Tax Deduction at Source

The issue of Tax Deduction at Source (TDS) is another factor, which need to be incorporated in the interest computation methodology. From the depositors’ point of view, this involves a partial premature withdrawal on March 31 (or even earlier on each calendar month-ends/quarter-ends/maturity) required for payment of tax on the interest income for the period April 1 through March 31. Different banks have adopted different procedures to carry out the process of TDS, which affects customer deposits. In this respect, a universal method need to be adopted by all banks and for that an appropriate method need to be decided upon. In this connection, one may look at Procedure C given in Das, Das and Das (1999), which considers the situation of partial premature withdrawals and ensures uniformity, exactitude, transparency and correctness for calculating interest.

The present study concentrates mainly on Term deposits. However, in a very recent observation it is found that in case of savings account deposits too there is no explicit method for computing interest. Here too due to the variation in the interest computation methodology the interest amount, for a month, on the minimum balance from the 10^{th} to the end of the month may vary between banks for a given fixed nominal rate of interest. One may think of a possible switch, in case of savings account, to interest being paid for a month based on the balance at the close of each day.

It is the right time to decide on a method, which is precise and without any ambiguity since most of the banks through a nation wide network are being centrally computerized. Any policy change at a later stage may cause inconvenience in terms of time and money for software/package modifications.

To conclude, in RBI's capacity as the guardian of public interest and regulator of financial systems, it may be justified to see the Central Bank come out with definite meanings and interpretations of terms, which directly relate to Term deposits – deposits which contribute to the bulk of public savings. There need to be a uniform method for interest computation involved in domestic Term deposits just like there may be one for the FCNR(B) or savings account deposit. Also, it is necessary to have a greater degree of transparency in regards to effective interest rates for depositors. It is interesting to note that in the recently announced annual monetary and credit policy for the year 2002-2003, the Governor of Reserve Bank of India has made some proposals in this direction to eliminate some of the uncertainties as described in this paper. However, it may be worthwhile to study the Federal Reserve's Truth in Savings Act, 1991, Truth in Lending Act, 1968 and similar acts in other countries in greater detail for incorporation of more customer protection policies in the Indian financial system.

The present paper is based on very few practical cases that we have come across. It might be worthwhile to take-up a more comprehensive study- but that would require an active involvement of the Reserve Bank of India and other institutions concerned.

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