Understanding interest rates

1.   Introduction

The way that interest rates are calculated and quoted can make a considerable difference to the true rate of interest. This note is intended to explain the principle of interest and how rates should be calculated in order to be comparable.

2.   Interest rates and inflation

Borrowers, or prospective borrowers, frequently complain about the level of interest rates, even when inflation is also high. An interest rate that is exactly equal to the inflation rate means that the sum repaid, in real terms, is equal to the sum borrowed. So the effective interest rate is zero. But calculating the true rate is not quite as simple as taking the interest rate and subtracting the inflation rate. Instead, use this equation:

$$\text{Real rate of interest} \quad = \quad \frac{1 + \text{nominal rate of interest}}{1 + \text{rate of inflation}} \; -1$$

By way of example, if the loan rate is 25 per cent, and the inflation rate is 15 per cent, then the real rate of interest is 8.7 per cent.

3.   Calculating annual interest rates

Some lenders quote their interest rates as, say 20 per cent (per annum), which they calculate as a percentage of the amount borrowed, then add to the amount borrowed, and then recover in equal instalments along with the loan. Let us look at an example. You borrow 100,000 for a year and a sum of 20,000 is added as interest. Is this 20 per cent? If you repay the loan all at once, at the end of the year, then you have been charged 20 per cent. If you pay the interest in instalments, but still repay the capital in one go at the end of the year, then you have still been charged 20 per cent.

But supposing you repay the capital in instalments as well. Suppose you repay the capital in two instalments, after 6 months and after 12 months. So now you have borrowed 50,000 for 12 months and a further 50,000 for 6 months. Twenty per cent of the capital that you borrowed for 12 months would be 10,000, but you are paying 20,000 so clearly you are being charged considerably more than 20 per cent overall.

But just how much are you paying?

Let us start by looking at the effect of compounding. Suppose you deposit money, say 100,000, in the bank and expect to receive 5 per cent each quarter. The interest is payable at the end of the quarter. You leave the interest in the bank, so each year the total increases more rapidly.

Table 1: Compound interest

Quarter	At start of quarter	Interest received	At end of quarter
1	100,000	5,000	105,000
2	105,000	5,250	110,250
3	110,250	5,513	115,763
4	115,763	5,788	121,551

Intuitively, you might have expected four quarters' interest at 5 per cent to be equal to 20 per cent, but because you also receive interest on the interest, the

effective rate is 21.5 per cent. This may not seem a big difference, but it can mount up. If interest is paid quarterly, then

Effective annual rate = (quarterly rate + 1)^4 – 1

We can, of course, do the calculation the other way around. If we know what annual rate is to be charged, we can calculate the quarterly or monthly interest that should be applied on the outstanding balance.

Quarterly rate = (fourth root of (annual rate +1)) – 1

So, if you are offered a loan at an apparent interest rate of 20 per cent, repayable in equal quarterly instalments, the real interest rate equates to 34.6 per cent. If you find this hard to believe, look at the calculation in the table below. An annual rate of 34.6 per cent is near enough a quarterly rate of 7.7 per cent.

Table 2: Compound interest at 7.7 per cent

Qtr	At start of quarter	Interest paid	Total repayment	Capital repaid	At end of quarter
1	100,000	7,713	30,000	22,287	77,713
2	77,713	5,994	30,000	24,006	53,707
3	53,707	4,142	30,000	25,858	27,849
4	27,849	2,148	30,000	27,852	- 3
Total		19,997		100,003	

To help you do the calculations, both for monthly repayments and for quarterly repayments, I have prepared a spreadsheet which you can download from my website, david.irwin.org.