Depreciation, Repaying Debt, and Recovering Capital
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Depreciation, Repaying Debt, and Recovering Capital

Payback Time (#41).

NOTE: THIS COVERS THE SAME GROUND AS THE PAPER, "~~BASIC MATH OF FINANCE," PP. 23-25~~. The present paper demonstrates the basic point in three other ways. See also the paper, "Calculating Mean Periods of Investment Using Normalized Models."

Depreciation and Amortization, Level Annuity

How much of an annual level payment received from an asset of finite flows is depreciation? The same formula shows amortization of the principal of a debt, using level payments for debt service (the normal way, aka installment plan payment).

Here are three methods of answering the question, all giving the same answer.

Notation:

D = Depreciation[1]
n = any current year
w = whole life
b = balance of life remaining[2]

Method One) Depreciation (D) as the loss in the PV of an asset over one year

Current annual Depreciation is the loss of PV over one year. It is measured here as [PV when b years of life remain] less [PV when (b-1) years of life remain]. The algebra follows:

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[1]In these models, Depreciation is perfectly keyed to repayment of debt, and provision of funds for replacement. The ideas are therefore interchangeable herein.

[2]b = w-n, where w is the original whole life, and n is the current year, measured from zero. This notation differs from that in the paper, "Basic Math of Finance." There c is used for current year, and t is used for whole life. I believe the notation used here is more mnemonic; I expect to change the "Basic" paper to the notation used here.

$$D = a[(1-I^{-b})/i - (1-I^{-(b-1)})/i] = (a/i)\cdot[I^{-(b-1)} - I^{-b}]$$

$$= (a/i)\cdot I^{-b}\cdot(I-1) = (a/i)\cdot I^{-b}\cdot i = aI^{-b}$$

$$D = aI^{-b} \qquad (1)$$

The bottom line, $D = I^{-b}$, is simpler than the process of reaching it. Current Depreciation is simply the basic single payment or PIPO Discount Factor, (our elemental building block), multiplied times the level payment a. That means the fraction of a that is Depreciation is simply the Discount Factor itself. (The Discount Factor (DF) is always less than one.)

Method Two) Depreciation as cashflow less interest.

In this method we first pay interest on the unrecovered balance, then impute the remainder of cashflow (a) to Depreciation. This partly resembles the method used in "Basic Math of Finance," but that uses division; this method uses subtraction. The "Unrecovered Balance" (B) is the original principal of a loan less the sum of paybacks previously made.

The math is the same when we apply it to real capital (K) stored up in plant and equipment. The unrecovered balance is the original capital input, K_o, less the sum of Capital Consumption Allowances (CCAs) previously taken. See note #1.

The unrecovered balance, B_n, is the DCF of a b-year annuity. "b" stands for the balance of life, i.e. the years of life remaining. This is neither the original whole-life, w, nor the number of years that have passed, n -- don't get mixed up about that. Remember it this way: b = w-n.

In any current year, n:

$$D = a-iB = a-ia\cdot(1-I^{-b})/i = a(1-1+I^{-b}) = aI^{-b} \qquad (2)$$

Again, the fraction of a that is Depreciation, D/a, is simply the DF, (I^{-b}). The shares of the DF and of Interest sum up to one. They are "complements." "Complement" is a good word to know: if

you already know it, accept my compliments (being careful to spell each homonym[3] right).

Method Three) Graphical Visualization.

On coordinates, Depreciation looks like this:

Figure 1: Value of Depreciation over One Year (it's the shaded area)

The shaded column is Depreciation when b years of life remain. The origin of the graph is not the original time zero, but the current year, n.

Method Four: Dividing Bi by a

See "~~Basic Math of Finance~~ Payback Time," Eqns. ~~(9,10)~~

Why do I give you four different methods of reaching the same bottom line? Three reasons, at least:

1, Your mind may turn on to one method better than another. Take your choice.

2, To show the consistency of what look like different pathways. Many routes lead to one truth. One of the best tests of truth is reaching it by different approaches.

3, To help you develop the art of reconciliation. It's a tragedy when hairsplitters divide into warring camps, as they will, over which pathway is correct, when they lead to the same goal. You can reconcile many needless disputes; you can often compose two problems into one solution. (Don't think, though, that correct analysis will always be enough. Many people have

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[3]A homonym is not a sexual orientation, but a word that sounds just like another word with a different meaning.

vested interests in their quarrels, and do not want them resolved.)

However you figure it, the fraction of the level payment, a, that is a payback of Principal is the DF. In numbers, that can be very small. For example, on a 40-year mortgage, at 11% interest, the share of the first payment that is payback is only 1.54%. That is not 1.54% of the debt, but of the first payment on the debt. As a share of the debt it is much smaller: 1.54% of 11.17%, or .17%. Over 99% of the first payments are pure interest.

Many debtors are appalled when they first learn that. It's only traditional, and good fun besides, to dump on the bankers. They're no angels, and some of them deserve censure for lots of things, but so do we all. The problem goes back to us: we volunteered to borrow for a long period. We volunteered to pay the going rate (probably thinking inflation would bail us out, as maybe it will). If the bankers had refused to lend, we would have railed at them for that.

Looking at it from the bankers' viewpoint, they have problems too: they aren't recovering their money any faster than the debtors are reducing their debts. Bankers can get in deep trouble tying up their funds in long-term loans at fixed rates of interest. All it takes is one of three things: a rise of current interest rates; inflation; or a drop in collateral values. All three have happened within recent memory; many lending institutions, notably S&Ls, have failed.