Corporate Income Taxation : (a) Depreciation

When a corporation purchases a durable asset (such as a machine, or a building), it cannot just subtract the cost of that asset from its taxable income in the year it purchased the asset (as it can with **current** expenses, such as salaries it pays its workers). Instead, it is allowed to claim **capital cost allowances**, usually referred to as depreciation allowances, over the life of the asset. [The same procedure applies to unincorporated businesses under the personal income tax. If a person owns an unincorporated business, she can deduct all current expenses of that business from the business's income, in calculating her taxable income. But capital expenses cannot simply be deducted in the year in which they are incurred. Instead, she must claim capital cost allowances over the life of the asset, just as a corporation must do in calculating its taxable income for the corporate income tax.]

For each durable asset, there is a table of depreciation rates, indicating what proportion of the cost of the asset can be deducted from a firm's taxable income, in each year of the asset's life. That is, for each class of asset, there are numbers assigned : $d_1, d_2, d_3, \ldots$, where d_t is the **fraction** of the original cost of the asset which can be deducted from the firm's taxable income in the t–th year that the firm owns the asset. In theory, these numbers are meant to indicate the actual running down, or technological obsolescence of the asset : the fraction of the original worth of the asset which is lost in that year, due to the machine becoming older. But the numbers in the depreciation schedules are really tax policy variables chosen by the tax authorities.

Usually, the d_t's add up to 1 : that is, eventually exactly 100 percent of the value of the asset is used up. Two common formulae for depreciation schedules are **straight line** and **declining balance**.

Under the straight line method, if the asset has an economic life of T years, then $d_t = 1/T$ for each of the first T years that the firm owns the asset. For example, 4–year straight–line depreciation would mean that the firm could deduct 25 percent of the original cost of the asset from its taxable income in each of the first four years it owned the asset.

More commonly used in Canada is the declining balance (or "exponential depreciation") method. Under that method, the value of an asset is assumed to shrink by some constant **percentage** each year. For example, if the percentage were 30 percent, then d_1 would equal 0.30. After one year, the value of the asset is assumed to have shrunk by 30 percent, to 70 percent of its original value. Then it would shrink a further 30 percent in the next year, so that $d_2 = (0.30)(1 - 0.30) = 0.21$. After 2 years it would have shrunk in value by $30 + 21 = 51$ percent, so that $d_3 = (0.30)(1 - 0.30 - 0.21) = 0.147$, and so on. (In theory, under this method, the value never shrinks to zero, and there would be some tiny but positive depreciation each year, no matter how old the asset.)

So the formula for the depreciation allowance on an asset which is t years old, if the method used is declining balance at a rate of δ, is

$$d_t = \delta(1 - \delta)^{t-1}$$

You can check that these d_t's do add up to 1 (over an infinite lifetime for an asset), no matter what is the depreciation rate δ.

If the d_t's add up to 1, then the firm eventually gets to deduct the total cost of the asset from its taxable income. But it should matter **when** the firm gets to deduct these costs. The earlier the better. The firm should care about the **present value** of the depreciation allowances,

$$\frac{d_1}{1+r} + \frac{d_2}{(1+r)^2} + \cdots$$

times the cost of the asset, where r is the interest rate which the firm uses to discount the future. Increasing d_1 a little, and lowering d_4 by the same amount will raise the present value of the depreciation allowances. The best possible depreciation allowance schedule for the firm would be one in which it could "expense" the asset : deduct immediately the full cost of the asset from current taxable income. This schedule would have a present value exactly equal to the cost of the asset. Any more gradual depreciation schedule, in which at least part of the depreciation cannot be claimed immediately, will have a present value less than the cost of the asset.

For example, what is the present value of a declining balance schedule, with the the rate of decline δ,? If the discount rate used to calculate present value is r, then the present value of depreciation, per dollar invested, is

$$\delta\frac{1}{1+r} + \delta\frac{(1-\delta)}{(1+r)^2} + \delta\frac{(1-\delta)^2}{(1+r)^3} + \cdots$$

which equals[1]

$$\delta/(\delta+r)$$

This present value is less than 1, and gets smaller the smaller is the allowed depreciation rate δ or the larger is the discount rate r.

So let $D \equiv dI$ be the **present value** of the depreciation schedule, where I is the initial cost of the asset. (d will depend both on the nature of the schedule, and on the discount rate r.). What

[1] Why? Let

$$a \equiv \frac{1-\delta}{1+r}$$

Then the present value of depreciation allowances could be written as

$$\frac{\delta}{1+r}(1 + a + a^2 + \cdots)$$

Now

$$1 + a + a^2 + \cdots = \frac{1}{1-a}$$

which equals

$$\frac{1+r}{r+\delta}$$

when $a = (1-\delta)/(1+r)$.

would be the value to the firm of buying some asset? The asset costs I. Suppose that buying the asset will increase the firm's total profit by x_t in year t. (In other words, x_t is the value of the marginal product of the asset in year t.) Let X be the present value of these increases in profits caused by the investment. (That is, $X = x_1/(1+r) + x_2/(1+r)^2 + \cdots$.) In the absence of the corporate income tax, the firm will buy the asset if and only if the present value of the added profits it brings, X, exceeds the cost I of the asset.

no tax : buy if $X > I$

If there is a corporate income tax, at the rate τ, then each added dollar of profits in any year will also increase corporate income tax liabilities by $\$\tau$. That means that the present value of the added profit (net of tax) from the asset is only $(1-\tau)X$. However, the firm gets to deduct its depreciation allowances each year from its taxable income. The present value of the reduction in tax from these deductions is τdI. So the total benefit of having the asset is now $(1-\tau)X + \tau dI$, and the firm's decision rule on whether to buy the asset is

tax : buy if $(1-\tau)X + \tau dI > I$

If the firm were allowed to deduct the cost of the asset immediately, then $d = 1$, so that the rule becomes : buy if $(1-\tau)X + \tau I > I$, which means buy if $(1-\tau)X > (1-\tau)I$, which is just the same rule as the *no tax* rule : I've just multiplied both sides by $1-\tau$. In such a case, the corporate income tax is said to be "neutral" with regard to the firm's investment decision : whether or not it chooses to buy an asset is unaffected by the corporate income tax rate.

However, with any other depreciation schedule (other than immediate deductability), the present value d is less than 1. That implies that

$$(1-\tau)X + \tau dI < (1-\tau)X + \tau I$$

so that the firm's decision rule is changed by the presence of the corporate income tax rate. The higher is the tax rate, the less attractive the investment becomes.

So it appears that having to wait into the future to deduct the costs of depreciation means that the corporate income tax tends to discourage investment.

However, it is important to notice that in this example no mention was made of the costs of financing the purchase of the asset. If the firm pays for the asset from cash on hand (that is, from retained earnings), or if it finances the cost by issuing new stock, then all the analysis is correct. However, if the firm borrows money to pay for the investment, then I have left out another benefit of investment : the costs of borrowing are deductible against the corporate income tax. In that case [investment to be financed at least in part by corporate borrowing], the results become more complicated, since the added deductions for borrowing costs must be considered. Then allowing immediate write–off of investment costs is no longer neutral (it actually encourages investment),

and it may not be true that investment is discouraged by corporate tax rate increases, even when the firm must write off the investment gradually.