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Time Value of Money*

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Introduction

If I promised you $1,000 today or offered to give you $1,250 in five years, would you wait? What factors are important as you decide whether to take money today or wait? How would you decide whether taking a costly action today was going to be worth it in the long-run? These questions and others are why the concept of time value of money is important. Every time you borrow or lend money, the concept of time value of money is at play when interest is calculated.

Business decisions are often made that have results over a long period of time. To make an informed decision we analyze the cost of tying up funds and expect to receive the funds returned plus interest. We expect to earn interest on these investments because we have a preference for using funds today and if we must wait to receive them, there should be a reward for that. The interest we earn is the reward or payment for waiting to have access to those funds.

Most individuals when presented with the decision of accepting $1,000 today or waiting one year for the same $1,000 would prefer to accept the money today. The decision becomes more complicated when the choice is between $1,000 today or $1,250 in five years. The $250 is serving as compensation for waiting. Is that enough? Determining the answer to that question involves the concept of time value of money.

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There are three valuable reasons for analyzing time value of money.

1. Alternative uses. Sometimes there is a decision to be made between two opportunities. I could spend $10,000 to plant trees, put that money into a new tractor, or invest the $10,000 in the stock market. If I choose to plant trees, then there is an opportunity cost to waiting for those funds to be free again and used for something else.

2. Uncertainty. It has famously been said that nothing is certain except death and taxes. With so few certainties in life, accepting money today is a sure thing instead of waiting for the promise of the money in the future. Many things could happen in that time period including your own increased need for money, increase in tax rates, or default on the part of the borrower. If given the opportunity to receive the funds today, you can be certain you have the use of them versus waiting to receive the funds from me in five years when I may or may not actually have the money to give you.

3. Inflation. For the most part we expect to see the price of goods and services rise. If we wait to receive the money in the future, it may not have the same purchasing power that it might have today. The tractor that cost $37,000 today may very well be closer to $43,000 in five years with a 3% inflation rate.

Compounding and Discounting

To be able to compare dollar amounts received at different periods in time, it is necessary to either compound or discount dollars to another period in time. This calculation allows us to convert sums today to an equivalent amount in the future (compounding) or to convert sums in the future to an equivalent amount today (discounting). The same formula is used to perform either calculation and involves moving variables around.

$$FV = PV\ (1 + i)^{n}$$

Where:
FV = future value, represents dollars received at a future point in time
PV = present value, represents dollars received at current time
i = interest rate or discount rate
n = number of periods (often is in years)

We can examine the proposed $1,000 received today and see what we might expect if we wanted to

earn 5% after one year. Using the formula,

$$FV = 1000\ (1+.05)^1 = \$1{,}050$$

After one year, we would expect to have $1,050. If we decided to put the $1,000 in an investment for five years we could expect to have $1,276.28. Earlier you were asked whether you would rather have $1,000 today or $1,250 in five years. Given an interest rate of 5%, you would rather take the $1,000 today because you can expect $1,276 instead of the $1,250 you were being offered.

Sometimes you know a future amount and would like to know how much that is equivalent to today. For example, if you need to have $5,000 in your account in 5 years and the account will earn 4%, how much should you put in the account today? We can solve this question using the same formula but solving for the PV.

$$PV = FV/(1+i)^n$$

$$PV = 5000 / (1.04)^5 = 4{,}109.63$$

For you to be able to have accrued $5,000 in five years, you must put in $4,109.63 if the investment pays 4%. Using the language from the previous question, if you put $4109.63 in the account, after five years at 4% interest you would have $5,000.

This is a powerful equation in that you can solve for any of the four variables by moving the pieces around. We could ask how long would it take for $3,000 at 4% to build to $5,000 (n =13 years). We could also determine what interest rate would be necessary to turn $3,000 into $5,000 in five years (i = 10.7%).

The above formulas can be a little tricky but using a spreadsheet or a calculator with built-in financial functions can make the job a little easier. In most cases, analysis of whether to do something or not requires comparing an expense today with a future outcome. The simplest solution is often to discount (calculate the PV) and compare the discounted future income to the expense required today.

Calculation of Interest/Discount Rates

One of the most important pieces of information entered into the above formulas is the interest or discount rate. This variable becomes increasingly important the longer the period of time involved. The interest rate is composed of three rates: the risk-free real return, inflation rate, and a risk premium.

The *risk-free real rate of return* is determined by finding the expected return on a very low risk investment. One of the lowest risk investments that is openly reported is US Treasury bills. Generally, government-issued securities (bonds or bills) are considered relatively risk-free as there is next to zero risk of default.

The *inflation rate* is based on actual inflation reported in recent years as well as estimates of future inflation. There are no hard and fast rules on how much of historical inflation to consider but it would be wise to understand that periods where the economy is doing exceptionally well or poor (such as during a recession) would have an impact on historical inflation. Your perception of the future and the length of time to be considered for the investment would have an impact on your estimate of future inflation levels.

The *risk premium* is your required compensation for taking a risk. The more risk-averse you are, the greater your risk premium should be. This implies that you would need a greater return on your investment to compensate you for the risk you are taking. Another individual who is less risk-averse will have a lower risk premium.

Example 1:

Risk-free real return	2.5%
Inflation	2.0%
Risk premium	4.0%
Before-tax discount rate	8.5%

Unless you are an entity in the United States that does not pay taxes, it would be necessary to adjust your discount rate to account for the impact of taxes. The after-tax discount rate is calculated by multiplying the before-tax discount rate by (1 – marginal tax rate). The marginal tax rate is the tax rate used to determine the tax paid on the last dollar of income.

After-tax discount rate = Before-tax discount rate x (1 – marginal tax rate)

For our example:

$$ATR = 8.5 \times (1 - .25) = 6.375\%$$

Returning to the earlier question of whether to accept $1,000 today or $1,250 in five years and using the after-tax discount rate:

$$PV = 1250 / (1+.06375)^5 = \$917.72$$

The discounted value of the $1250 is equivalent to $918 which is less than the $1000 that is offered. Given your discount rate, you would be better off taking the $1,000 today. The $250 is not enough to compensate for the opportunity cost, uncertainty and expected inflation.

Applications

Using the time value of money calculations can answer many business and tax-related questions. The longer the delay between expenditure and income, the more important it is to understand how these concepts work. You can see these calculations at work when taking out a loan on a piece of equipment or when having a property appraised for sale or purchase.

There are elections within the tax code that provide the opportunity to expedite deductions or defer taxes. It may seem like an easy decision to deduct today or postpone the tax until later however, using the time value of money calculations you can be certain by using current and future expected tax rates and inflation.

To spur investment, Section 179 of the IRC allows certain qualifying assets that normally cannot be entirely deducted in one year to be expensed in whole or in part during the first year the asset is put into service. (See RuralTax.org Article RTE/2010-19. Depreciation: Election to Expense Qualifying Assets (Section 179 Deduction)). Taking a Section 179 deduction now is generally preferred over future depreciation deductions over the life of the property. However, if the marginal tax rate is expected to increase over time, it may be better not to take the deduction and claim depreciation deductions later.

Example 2: Consider a depreciable property with a basis equal to $1,000. If the marginal tax rate is currently low, say 10%, the tax savings from the Section 179 deduction would be $100 ($1,000 x .10). Over time as income and marginal tax rate increases, the savings from taking depreciation annually would be larger in total than taking the Section 179 deduction currently. The amount deducted doesn't change but the impact of the deduction changes based on the marginal tax rate (see Table 1).

Table 1. Tax savings from depreciation deductions with increasing tax rate.

Year	Depreciation	Marginal Tax Rate (%)	Tax Savings	5% PV Factor	PV of Tax Savings
0					
1	$200	10	20	.9524	19.05
2	$200	12	24	.9070	21.77
3	$200	22	44	.8638	38.01
4	$200	24	48	.8227	39.49
5	$200	32	64	.7835	50.14
				Total PV	167.55

In the above example, utilizing the Section 179 deduction results in a $100 tax savings. Choosing to take the depreciation deduction over the five-year life of the asset (resulting in $200 depreciation deduction each year) and accounting for increasing marginal tax rates and a five percent discount rate, the total tax savings is $167.55. What appeared to be an easy decision to take the deduction immediately actually results in less tax savings by $67!

To make accurate decisions regarding whether to deduct immediately or wait, you should examine the cash flows and tax savings accounting for time. The same calculation could be performed for decisions on leasing versus buying equipment or whether to postpone recognition of gain on a sale.

Conclusion

We make many decisions without running the calculations. However, if you are trying to make business-related decisions involving expenses and income that do not occur in the same year, it would be prudent to take a moment to see the opportunity costs and tax savings from your different options. You might find the "obvious" answer isn't the correct one.

Additional Topics

This fact sheet was written as part of Rural Tax Education a national effort including Cooperative Extension programs at participating land-grant universities to provide income tax education materials to farmers, ranchers, and other agricultural producers. For a list of universities involved, other fact sheets and additional information related to agricultural income tax please see RuralTax.org.