Time Value of Money

Real Estate Principles

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Time Value of Money

> *Money in the future is less valuable than money today.*

The **Time Value of Money (TVM)** concept applies to both business and personal activities. Why is money in the future worth less than today? Or to put it another way, why is money today worth more than the same amount in the future?

- **Earnings:** You can put money today into an investment and earn more money from it. For example, you could put it into a bank account and earn interest - essentially risk free in the U.S. with an FDIC insured bank. If you are comfortable with more risk, you could invest it into stocks, or real estate, or your own business.
- **Inflation:** The same amount of money in the future can't buy you as much as it can today. Most economies experience inflation, meaning that goods in the future will cost more than those same goods today (think of buying a soda 50 years ago, it was probably a lot lower price than today. What will it cost in another 50 years!?). You can do more with $10 today than you will be able to in the future.

Future Value

> The **Future Value (FV)** equals the amount of money some number of periods (years, months, etc) in the future at a given interest rate.

Working with the TVM principle, we know that future money is worth less to us than the same amount of money today. We'd much rather prefer to have $10 today, than the same $10 in 1 year's time. Unless you're a bit crazy (sometimes referred to as irrational in investment circles). But there must be some amount of *expected* money in the future that would convince us to give up our $10 today. Would we want $15 dollars in 1 year for us to give up our $10 today? $20 in 1 year? $30? This principle is the essence of investing. An investor gives up money today (i.e. invests it into a business or an asset) in return for getting a higher amount in the future. The amount of money that you want in the future for investing your $10 (or some other amount) today is a function of risk. The greater the risk, the larger the interest rate at which your money should be expected to grow. Some of those risks would be:

- the length of time you have to wait - the longer you have to wait, the more money you want to make
- the risk you perceive in the investment you are making - the higher the risk, the more money you want to make
- the return you would get on other types of investment (usually measured against the risk free rate of return)

The formula for Future Value

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

where:

- **i** is an interest, or discount rate
- **n** is the number of periods

Present Value

> **Present Value (PV)** equals the current, or present value of future cash flows, discounted at a selected interest (discount) rate.

This is looking at the $10 investment situation from the other direction. If you expected to receive $10 in one year's time, a rational investor would pay less than $10 for that opportunity. Again, the amount you would pay today is a function of the risk of the deal, the length of time you have to wait and the return you can get on other types of investment. All of these factor into the discount rate. So how much is that $10 in 1 year worth today? Well, that value is known as the Present Value.

Discount Rate

Discounting means the process of finding the Present Value by reducing future cash flows using a discount (interest) rate. If you expect to earn that $10 in the future, we need a number to calculate its present value. The rate at which we discount money is called the discount rate. The discount rate is a function of the risk (how likely are we to receive that expected money)? Looking at this from the other direction, the discount rate is the rate at which your Future Value is reduced to the Present Value.

The formula for Present Value

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

where:

- **i** is an interest, or discount rate
- **n** is the number of periods

Calculating PV in Excel

In MS Excel, the formula is

=PV(rate,nper,pmt,[fv],[type])

- Rate is the interest rate.
- NPER is the number of periods
- PMT is a recurring payment stream
- FV is the expected value of some dollar amount N periods in the future.
- TYPE (optional) is whether the cash flow is ordinary (regular) annuity where payments are made: at the end of a period (0, or blank/default) or an annuity due where payment are made at the beginning of a period (1).

Calculating PV with HP10bII+

1. **Turn On the Calculator**:
    - If the calculator is off, press the **ON** button.
2. **Clear Time Value of Money Memory**:
    - Press the **orange shift key.**
    - Then press **C All**.
3. **Enter the Future Value (FV)**:
    - Key in the future value amount.
    - Press the **FV** key (this will store the future value).
4. **Enter the Interest Rate (i)**:
    - Key in the annual interest rate in percentage form (e.g., for 5%, just type 5).
    - Press the **I/YR** button (this will store the interest rate per year).
5. **Enter the Number of Periods (n)**:
    - Key in the number of years or periods the money will be invested or loaned for.
    - Press the **N** button (this will store the number of periods).
6. **Compute the Present Value**:
    - Now, press the **PV** button. The calculator will now display the Present Value.

Note: If you're dealing with periodic compounding (like monthly or quarterly), ensure that you adjust the **i** (interest rate) and **n** (number of periods) accordingly. For instance, if compounding is monthly, and you're considering a 5-year period, **n** will be 60 (12 months x 5 years). Similarly, if the annual interest rate is 5%, and it's compounded monthly, then it will be 5/12.

Example From the Video

1. Turn On the Calculator:
    - Press the **ON** button.
2. Clear Previous Work:

- Press the orange shift key and then press **C ALL**.

3. Enter the Future Value (FV):
    - Key in **5000**.
    - Press the **FV** key.
4. Enter the Interest Rate (i):
    - Key in **8**.
    - Press the **I/YR** button.
5. Enter the Number of Periods (n):
    - Key in **3**.
    - Press the **N** button.
6. Enter the Periodic Payment (PMT):
    - Key in **0**.
    - Press the **PMT** button.
7. Compute the Present Value:
    - Press the **PV** button. The calculator will now display the Present Value.

After following these steps on the HP10bII+, the calculator should display a result of approximately $3,969.16 as the present value, which matches the result on the video.

Calculating FV in Excel

In MS Excel, the formula is:

FV(rate,nper,pmt,[pv],[type])

- Rate is the interest rate.
- NPER is the number of periods
- PMT is a recurring payment stream
- PV is the value of current monetary holdings.
- TYPE (optional) is whether the cash flow is ordinary (regular) annuity where payments are made: at the end of a period (0, or blank/default) or an annuity due where payment are made at the beginning of a period (1).

Calculating FV with HP10bII+

1. **Turn On the Calculator:**
    - If the calculator is off, press the **ON** button.
2. **Clear Time Value of Money Memory**:
    - Press the **orange shift key.**
    - Then press **C All**.
3. **Enter the Present Value (PV):**
    - Type in the amount of the present value.
    - Hit the **PV** key (this action stores the present value).
4. **Key in the Interest Rate (i):**
    - Input the annual interest rate, represented as a percentage (for instance, for 6%, simply input 6).
    - Push the **I/YR** button to register the yearly interest rate.
5. **Specify the Number of Periods (n):**
    - Input the number of years or periods over which the money will grow.
    - Press the **N** key to record the duration.
6. **Calculate the Future Value:**
    - Finally, tap the **FV** button. The calculator will display the Future Value.

Note: For cases involving periodic compounding (e.g., monthly or quarterly), it's crucial to adjust the values for **i** (interest rate) and **n** (number of periods) accordingly. For example, if interest is compounded monthly over a span of 5 years, **n** would equal 60 (12 months x 5 years). In a similar vein, an annual interest rate of 6% compounded monthly would have been set as 6/12.

Example From the Video

1. **Turn On the Calculator**:
    - If the calculator is off, press the **ON** button.
2. **Clear Previous Work**:

- To ensure accuracy, clear any previous calculations. Press the **orange shift key** followed by **C ALL**.

3. **Enter the Present Value (PV)**:
    - Key in **24**.
    - Press the **PV** key.
4. **Key in the Interest Rate (i)**:
    - Input **10** (representing the 10% interest rate per period).
    - Press the **I/YR** button.
5. **Specify the Number of Periods (n)**:
    - Key in **400** (representing 400 periods).
    - Press the **N** button.
6. **Enter the Periodic Payment (PMT)**:
    - Key in **0**.
    - Press the **PMT** button.
7. **Calculate the Future Value**:
    - Now, press the **FV** button. The calculator will display the Future Value of approximately 8.655363*10^17 ($).

Calculating Return on Investment in Excel

In MS Excel, the formula is:

=RATE(nper,pmt,pv,fv,[type],[guess])

- Rate is the interest rate.
- NPER is the number of periods
- PMT is a recurring payment stream
- PV is the value of current monetary holdings.
- *TYPE (optional) is whether the cash flow is ordinary (regular) annuity where payments are made: at the end of a period (0, or blank/default) or an annuity due where payment are made at the beginning of a period (1).*
- *Guess (optional) is where the user inputs a guess as to the answer. Excel solves this problem iteratively and may, occasionally, need a starting point closer to the ultimate answer to properly solve a given set of inputs.*

Calculating ROI with HP10bII+

1. **Turn On the Calculator**:
    - If the calculator is off, press the **ON** button.
2. **Clear Time Value of Money Memory**:
    - Press the **orange shift key.**
    - Then press **C All**.
3. **Enter the Present Value (PV)**:
    - Input the present value amount.
    - Press the **PV** key to store the present value.
4. **Enter the Future Value (FV)**:
    - Key in the future value amount.
    - Press the **FV** key to store it.
5. **Specify the Number of Periods (n)**:
    - Input the number of periods or years over which the investment grew or will grow.
    - Press the **N** button to store the number of periods.
6. **Enter the Periodic Payment (PMT) if any**:
    - If there are regular investments or withdrawals, key them in. Otherwise, enter **0**.
    - Press the **PMT** button.
7. **Calculate the Investment Return**:
    - Press the **I/YR** button. The calculator will display the investment return or interest rate.

Note: When dealing with varying compounding frequencies (e.g., monthly or quarterly), ensure that **n** (number of periods) is adjusted appropriately. For instance, if compounding is quarterly and you're looking at a 4-year investment, **n** will be 16 (4 quarters x 4 years). Similarly, ensure that the interest rate displayed is interpreted correctly based on the compounding frequency.

Example From the Video

1. **Turn On the Calculator**:
    - If your HP10bII+ is off, press the **ON** button.
2. **Clear Previous Work**:
    - Press the **orange shift key** and then press **C ALL**.
3. **Enter the Present Value (PV)**:
    - Input **-1000** (Note: The present value should be entered as a negative since it's an outflow of cash).
    - Press the **PV** key.
4. **Enter the Future Value (FV)**:
    - Input **1500**.
    - Press the **FV** key.
5. **Enter the Number of Periods (n)**:
    - Key in **5**.
    - Press the **N** button.
6. **Enter the Periodic Payment (PMT)**:
    - Key in **0** since there's no periodic payment.
    - Press the **PMT** button.
7. **Calculate the Interest Rate**:
    - Press the **I/YR** button.

After pressing the **I/YR** button, the HP10bII+ calculator should display the annualized interest rate for the given set of assumptions. If you follow these steps on the HP10bII+ calculator, it should display an interest rate of approximately 8.45%. This is the compounded annual growth rate required to grow $1000 to $1500 over 5 years.

Calculating Number of Periods in Excel

In MS Excel, the formula is:

=NPER(rate,pmt,pv,fv,[type])

- Rate is the interest rate.
- NPER is the number of periods
- PMT is a recurring payment stream
- PV is the value of current monetary holdings.
- *TYPE (optional) is whether the cash flow is ordinary (regular) annuity where payments are made: at the end of a period (0, or blank/default) or an annuity due where payment are made at the beginning of a period (1).*

HINT Remember, these problems are cash flow problems not simply math problems. You must input PV as negative for the a spreadsheet or calculator to solve the problem.

Calculating Number of Periods with HP10bII+

1. **Turn On the Calculator:**
    - If the calculator is off, press the **ON** button.
2. **Clear Time Value of Money Memory**:
    - Press the **orange shift key.**
    - Then press **C All**.
3. **Enter the Present Value (PV):**
    - Key in the present value amount.
    - Press the **PV** key (this will store the present value).
4. **Enter the Future Value (FV):**
    - Key in the **FV** amount.
    - Press the **FV** key (this will store the future value).
5. **Enter the Interest Rate (i):**
    - Key in the **annual interest rate** in percentage form (e.g., for 5%, just type 5).
    - Press the **I/YR** button (this will store the interest rate per year).
6. **Compute the Number of Periods:**
    - Now, press the **N** button. The calculator will now display the number of periods required for the present value to reach the future value at the specified interest rate.

Note: If you're dealing with periodic compounding (like monthly or quarterly), ensure that you adjust the i (interest rate) accordingly. For instance, if compounding is monthly and the annual interest rate is 5%, then it will be 5/12.

Example From the Video

1. **Turn On the Calculator:**
    - If the calculator is off, press the ON button.
2. **Clear Previous Work:**

- It's a good practice to clear any previous calculations. Press the **orange shift key** and then press **C ALL**.

3. **Enter the Present Value (PV):**
    - Key in **-3000** (negative because it's an outflow of money).
    - Press the **PV** key (this will store the present value).
4. **Enter the Future Value (FV):**
    - Key in **4000**.
    - Press the **FV** key (this will store the future value).
5. **Enter the Interest Rate (i):**
    - Key in **6** (representing the 6% annual interest rate).
    - Press the **I/YR** button (this will store the interest rate per year).
6. **Enter the Periodic Payment (PMT):**
    - Key in **0**.
    - Press the **PMT** button (this will store the periodic payment).
7. **Compute the Number of Periods:**
    - Now, press the **N** button. The calculator will now display the number of periods required for a $3000 investment to grow to $4000 at a 6% annual interest rate.

Result: Upon following the steps and pressing the N button, the calculator will display the number of periods, which should be equal to 4.94.

Note: If you're dealing with periodic compounding (like monthly or quarterly), ensure that you adjust the i (interest rate) accordingly. For instance, if compounding is monthly and the annual interest rate is 6%, then it will be 6/12.

Compounding

> Compounding is the process where money earns interest on the initial balance plus all previously earned interest. It results in an exponential growth curve.

Say you invest $100 into a bank account which generates a 5% interest rate. At the end of that first year, you would have $105. But how much would you have at the end of the second year?

If you apply simple interest (i.e. non-compounding), where interest is only earned on the principle you invest, you would have $110.00 ($105 + $100 * 0.05) at the end of year 2. However, if you applied compounding, you would have $110.25 (105*1.05). The reason you would have more is that you are also earning interest on the extra $5 of interest you earned at the end of year 1. In a way, the interest you earned in the past becomes principle.

In real life, investments and savings follow the law of compound interest, not simple interest. This means if you make earnings on your earnings as well as the initial amount you invest.

This makes a big difference over time. You'll see that simple interest (also known as simple growth) is linear, it increases in a straight line, whereas compounding is exponential.

The further out in time and the higher the interest rate, the greater the effect of compounding.

	Periods						
Rate per Period		1	3	5	10	20	50
	4.00%	$104	$112	$122	$148	$219	$711
	8.00%	$108	$126	$147	$216	$466	$4,690
	12.00%	$112	$140	$176	$311	$965	$28,900
	16.00%	$116	$156	$210	$441	$1,946	$167,070
	20.00%	$120	$173	$249	$619	$3,834	$910,044

Discounting

> Discounting means the process of finding present value by reducing future cash flows using a discount (interest) rate. Discounting over time is the inverse of compounding.

Nothing more needs to be said about Discounting really. It is the opposite of Compounding. As opposed to an interest rate, it's called a discount rate, since it reduces values in the future, back to their present values.

Create Your Multiple-Choice Question

"The best way to learn is to teach."- *Seneca (Roman Philosopher, 4 BC - 65 AD)*

To reinforce and deepen your understanding of this module's concepts, create at least one multiple-choice question based on any of the elements you have learned in this module. Click here to create your question(s).