I) **The Investment Decision.** This is the question of whether a firm should invest in a project or which projects it should invest in. How should the firm allocate its capital?

II) **The Capital Structure Decision.** This is the question of how the firm should finance the projects in which it is investing. A very simple version of this question is should the firm use debt or equity. The problem with this simple version of the question is there are an infinite variety of the kinds of debt and equity which a firm can issue. Should the firm issue public or private debt (or equity)? Should the firm issue long term or short term debt, fixed rate or floating rate debt, debt denominated in dollars or ¥? The capital structure question also subsumes risk management: should a firm manage its risk and if so how?

III) **The Dividend (Payout) Decision.** Once the firm has raised capital and invested, it must decide what to do with the capital it receives as a return. It can reinvest cash it receives from the project or return it to investors such as equity holders. If it returns the capital it to equity holders, it must decide how to return the capital. Does the firm pay a dividend or repurchase stock?

Almost every finance question you run into can be posed as a version of one (or more) of these three questions. Thus if I (and your other finance instructors) can teach you the answers to these three questions, we have prepared you for any finance question you will ever see.

I) **The Investment Decision.**[2] The most fundamental finance decision which a firm must make is the investment decision. More value is created or destroyed by investment decisions than any other financial decision. There are three basic ways to value projects: discounted cash flow, real options, and multiples (see Figure 2).

A) **Discounted Cash Flow (DCF).** The most fundamental way to value projects is the discounted cash flow (DCF) or the net present value (NPV) approach. To value a project using DCF, we forecast the expected future cash flows which the project will generate and discount them at the risk-adjusted discount rate. This gives us the value of the project (or the value of the idea) today. The NPV is the value of the future cash flows minus the price (today's cash flow). If the NPV of the project is positive (the value of the project is greater than its price), then investing in the project creates value. If the NPV of the project is negative (the value of the project is less than its price), then investing in the project destroys value.

$$NPV_{Asset_A} = \sum_{t=1}^{N} \frac{CFA_t}{(1+r_A)^t} - CFA_0 = \frac{CFA_1}{(1+r_A)^1} + \frac{CFA_2}{(1+r_A)^2} + \frac{CFA_3}{(1+r_A)^3} + \ldots + \frac{CFA_N}{(1+r_A)^N} \quad (1)$$

=Value- Price

This is the easy part. Once you have the cash flows and the discount rate, calculating the NPV is basic math, and better yet, Excel will do it for us.[3]

1) **Expected cash flow from assets (CFA)**. The expected cash flows are the amount of cash the project (asset) is expected to consume (if the number is negative) or generate (if the number is positive) in a given year. Negative numbers are the amounts that must be invested in the project, positive numbers are the amounts that can be distributed to investors or invested in other projects. These cash flows are the expected cash flows, not necessarily the actual cash flows. They are forecasts, and as such may be (probably will be) wrong. All that we require is that they are correct on average or that they are not systematically wrong (systematically too high or systematically too low).[4]

(a) **Profits**. A forecast of cash flow will begin with profits, but the definition of profits will be slightly different from what you are used to from accounting.

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(1) **Sales**. The best place to start is with a forecast of sales. When

[2] This is also called the capital budgeting decision. This is a historic term. It comes from a time period when we thought about firms having a budget for capital investment. If the firm or division exhausted its capital budget before the end of the year, it would quit investing – even if it still had good (value increasing) projects in which to invest. As I describe the way we evaluate projects and decide whether to invest, think about where the capital budget is.

[3] The function NPV[rate, first_cell:last_cell] calculates the NPV of the cash flows in *first_cell* to *last_cell* using a discount rate of *rate*. Be careful, however. Excel assumes the first cash flow occurs one year from today (if you are using an annual discount rate). If your first cash flow occurs today, you need to include this cash flow as a separate term.

[4] We are going to forecast cash flows multiple years in the future and then make decisions based on them. This often bothers people who are new to DCF. Good. A little cynicism or reflection seems like a very good thing here. However, you don't have a choice. If you are going to decide to make a multi-million dollar investment in a project that will produce cash flows over the next three decades, I know of no other way to estimate the value of the project than to estimate what value this investment will generate in the first, the 15th and the 30th year of the project. The discomfort with making such long range forecasts isn't a problem with NPV (the solution); it is a problem with the question you are asking. Is this 30 year investment a good one?

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thinking about how to forecast sales, you should consider the dynamics of the economy and the product market over the forecast period. If the economy is coming out of a recession, it will grow faster than normal. What effect will this have on the sales growth of your product? Is your product a mature one, and so the total market sales are growing slowly, or is it a new product where the sales of the entire market are growing rapidly. Finally, sales growth will be determined not just by the growth of demand for the product or service, but also by changes in market share.

(2) **Profit margin**. You can forecast costs (costs of goods sold plus selling, general, and administrative expense) or you can forecast the profit margin. They should be numerically identical. When forecasting profit, think about what will cause the profit margin to rise or fall over your forecast period. Profit margins may rise as you learn the production process and become more efficient (learning by doing). If there are economies of scale, costs per unit will fall and the profit margin will rise with unit sales. The profit margin will change in response to competition. It may rise as we develop market power or decline as we lose market power and competitors enter. Business cycle changes will also alter the profit margin.

(3) **Depreciation.** When writing down the expression for profits, I will include depreciation as a separate term. It is often included in Cogs or SGA. I do this because depreciation is a non-cash cost. No cash leaves the firm when the firm incurs a depreciation expense. I will explain this more fully below.

(4) **Interest**.[5] To value a project or an asset, we discount the cash flow from assets (CFA). These are the cash flows generated by the project that can then be distributed to debt holders as interest and principal repayments or to equity holders as dividends or stock repurchases if positive. If CFA is

[5] Consistency gets you a long way in finance. If you want to value an asset, discount the cash flow from assets (CFA) at the asset discount rate. If you want to value the debt, discount the cash flow to debt (CFD) at the debt discount rate. If you want to value the equity, discount the cash flow to equity (CFE) at the equity discount rate. When calculating the cash flow from assets if you subtract off interest AND principal repayments from cash flow from assets (i.e. you subtract off the debt cash flows), you have cash flow to equity. These cash flows can be discounted at the equity discount rate to get the value of equity. If you subtract off interest but not principal repayments, you do not have cash flow from assets or cash flow to equity. This number is junk and can't be used to value anything interesting.

$CF_A = CF_D + CF_E$ $A = D + E$

$$\frac{CF_A}{1+r_A} = \frac{CF_D}{1+r_D} + \frac{CF_E}{1+r_E}$$

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negative, this is the capital that must be raised from investors. This means we need to calculate the cash flow available to pay our capital providers. We therefore do not subtract off any payments to capital providers when we calculate cash flow from assets. Thus even if the firm has debt, we do not include the interest they pay in our calculation.

(5) **Taxes**. Once we have earnings before interest and taxes (EBIT), subtract off taxes and you have after-tax profits.

$$\text{Profits} = \text{Revenue} - \text{Costs} - \text{Depreciation} - \text{Taxes}\left[R - C - D\right] \tag{2}$$

(b) **Net investment**. One difference between finance and accounting is accountants focus on profits and finance professionals focus on cash flow.[6] Cash flow is the amount of cash which can be removed from a project and given to investors. It is equal to profits minus net investment. Thus the next set of terms is the amount of cash which must be reinvested in the business and thus is not available to pay capital providers.

(1) **Net investment in long term capital**. Our objective is to calculate how much cash is generated or consumed by the project each year in expectation. The problem with using profits directly, is not all revenues represent immediate cash inflows and not all cost represent immediate cash outflows.

a) **Capital expenditure is a cash outflow**. When a firm purchases a piece of property, plant, or equipment (PPE), it takes cash away. Thus capital expenditure is a cash outflow in the year they occur.

b) **Depreciation is a cash inflow**. Financial statements do not treat capital expenditures as a cost in the year the capital is purchased. Capital investments are capitalized and then depreciated over the life of the asset. The problem for finance is the cash leaves the firm when the firm purchases the capital equipment, not when the accountant says the asset depreciates. Thus to calculate cash flow from assets, we subtract off capital expenditure and add back depreciation.

c) **Equipment sales**. When the firm no longer needs a piece of equipment, it may sell it. This is like negative capital expenditure and is a positive cash flow (the salvage value). The sale of capital equipment can also generate a tax liability. Thus if your forecasts include the sale of capital equipment you need to add the proceeds from the sale and

[6] The reason finance is so careful with the timing of cash flows is discounting. 100 received next year is not worth $100. Thus to correctly value a project we need to know when cash flows in and when cash flows out and thus how many periods to discount the cash flow.

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subtract off the tax payment due to the sale.[7]

(2) **Net investment in short term capital**.

a) **Net working capital (NWC) – finance definition**. In accounting, net working capital is defined as current assets minus current liabilities. In finance, net working capital is defined as current assets (excluding cash) minus current liabilities (excluding short term debt). As an illustration, I often use accounts receivable and inventory as my current assets and accounts payable as current liabilities. Other current assets (e.g. prepaid expenses) or current liabilities (e.g. accrued expenses) should be included if the firm has them. Revenue is recognized when a sale occurs, not when cash flows into the firm. By adjusting for changes in net working capital, we move revenues from when the accountant said they occur to when the cash flows into the firm and we move costs from when the accountant said they occur to when the cash flows out of the firm.

b) **Increases in NWC are a cash outflow**. This is why we subtract off increases in net working capital. Increases in accounts receivable reduce cash flow. Increases in inventory reduce cash flow. Increases in accounts payable increase cash flow. The income statement says we receive revenues when a sale is made, not when cash comes into the firm. Thus to offset this effect, we subtract off the increase in accounts receivable.

c) **Exclude short term debt from NWC**. Current liabilities include short term debt (both notes payable as well as the current portion of long term debt). These accounts need to be excluded from NWC when we calculate cash flow from assets (CFA). The logic is the same as why we exclude interest. Changes in short term debt are debt repayments (if the level shrinks) or debt issues (if the level rises). These are payments to debt holders. Since we want cash flow from assets (the cash available to pay capital providers such as debt holders), we don't

[7] When a firm sells a piece of property, plant, or equipment, they usually incur a capital gain. This is like the capital gain you incur when you sell stock. If you purchase a share of stock for 100 and later sell it for 110, you have incurred a capital gain of 10 (110-100), and thus owe taxes on the capital gain at the capital gains tax rate. The idea is similar for capital equipment. However, with capital equipment, the capital gain is the sales price minus the tax basis. The tax basis is the purchase price minus accumulated depreciation. For example, assume you purchased a piece of equipment for 100 and then depreciate the equipment straight line over 10 years (i.e., your depreciation expense is 10 a year for this equipment). If you sell the equipment for 90, after taking two years of depreciation, the tax basis is 80 (100 - 10 - 10). The capital gain upon which you would owe tax is thus 10 (90 -80).

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want to subtract off cash flows to debt holders such as interest or short term debt repayments.

d) **Exclude cash from NWC**. Cash flow from assets is the change in cash. Our objective is to find out how much our cash balance increases (and thus could be paid to capital providers) or decreases. If we included changes in cash as part of NWC, we would discover that our cash flow from assets was zero by construction.

e) **Recapture of net working capital**. If we shut a project down, we would collect the accounts receivables, sell off the inventory, and pay off the accounts payable. Thus in a finitely lived project, we need to zero out the NWC account or recapture the NWC. This will be a positive cash flow in the final year of a finitely lived project.

(c) **Cash flow from assets formula (CFA)**. The formula that will be at the bottom of your spreadsheet is:

$$\begin{aligned} \text{Cashflow}_{\text{Assets}} &= \text{Revenue} - \text{Costs} - \text{Depreciation} - \text{Taxes}\left[\text{Rev} - \text{Costs} - \text{Depr}\right] \\ &+ \text{Depreciation} - \text{Capital Expenditure} - \text{Increase in NWC} \\ &+ \text{Salvage value} - \text{Taxes on salvage value} + \text{Recapture of NWC} \end{aligned} \tag{3}$$

To value the project you will discount these cash flows at the risk- adjusted discount rate for assets.

2) **Risk-adjusted asset discount rate.** To know the correct discount rate for a project, we need to know the rate of return which our investors require to hold the asset and bear the risk inherent in that asset. This is the expected rate of return that they could earn on an asset of equivalent risk.

(a) **Return on the firm's assets.** If we can calculate the expected return on the firm's assets, this will be the firm's cost of capital.

(1) **Assets are a portfolio.** When you invest your personal or pension investments, you allocate your capital across different assets (e.g., stocks and bonds). The value of your portfolio is the sum of the value of all the different assets in your portfolio. We can think of a firm's assets in the same way. The assets of the firm are the sum of the values of the firm's securities. How can a firm be financed? They can be financed with bank loans, public bonds, preferred equity, and common equity. I will use the simple example where the firm is financed with simple debt and equity.

$$\text{Assets} = \text{Debt} + \text{Equity} \tag{4}$$

(2) **Return on portfolio**. How do you calculate the return on your investment portfolio? You take the weighted average of the return on each of your investments, where the weights are the fraction of the portfolio's market value which is invested in each asset. As an example, assume you had $100

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invested in Sara Lee equity and $200 invested in Toyota equity. If the return on Sara Lee's equity was 15% this past year and the return on Toyota's equity was 6%, what is the return on your portfolio? 9%

$$r_{portfolio} = \frac{100}{100+200} 15\% + \frac{200}{100+200} 6\% = 9\% \quad (5)$$

(3) **Expected return on firm's assets**. Since the firm's assets are equal to its debt plus its equity, we calculate the return on the firm's assets using the same method.

$$r_{assets} = r_{debt} \frac{D}{D+E} + r_{equity} \frac{E}{D+E} \quad (6)$$

This is the rate of return which investors receive on their investments. If the return on debt and equity are expected returns, then this is the expected rate which investors require to hold the firm's assets. This is their opportunity cost of capital. Since this is the expected return which investors could earn on investments of equivalent risk, the market (investors) will only finance your project(s) if it has an expected return larger than this cost of capital.

(4) **Financial leverage.** Financial leverage is the amount of debt standing between the firm's assets and the equity holders. The more debt a firm has, the more levered the firm is. Increasing leverage increases the risk of the equity and the expected return on the equity. To see this we can re-arrange the above equation.

$$r_{equity} = r_{assets} + \frac{D}{E}(r_{assets} - r_{debt}) \quad (7)$$

The equity is riskier than the assets because the firm is levered ($r_{equity} > r_{assets}$). The debt places a fixed commitment between the risky asset cash flows and the payments to equity holders. The risk of the assets is concentrated on a smaller equity base. The equity is therefore riskier the more debt the firm has.

(b) **Source of capital: Debt and equity.** To calculate the cost of capital for a firm, we need to know where to look up or estimate all the numbers in the cost of capital formula (equation 6). The first set of numbers we need is the debt and equity ratios. This is the fraction of the firm which is financed with debt and with equity.

(1) **Market value ratios.** Market ratios are the correct number. The ratios denote the fraction of your money which is invested in equity and the fraction which is invested in debt. Thus you want to calculate the equity percent as the market value of equity over the market value of equity plus the market value of the debt. The equity value is calculated as the number of shares outstanding times the stock price. This is also the market capitalization of the firm's equity.

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(2) **Book values.** Market values of debt are sometimes unavailable. In these cases, book values can be used as an estimate of market values. This is most common with debt values. The book value of debt is a good estimate of the market value of debt when the debt has just been issued. In this case, the two are the same. However, book values of debt are poor estimates if the level of interest rates or the riskiness of the debt has changed significantly since it was issued.

(c) **Cost of debt.** Once we know how much debt and equity we have, we need to calculate the cost of the debt and the equity. The cost of debt can be calculated from the rate the firm pays on its debt. There are three rates of return when it comes to debt. It is essential they be clear in your mind. If not, you might use the wrong one when calculating the cost of capital.

(1) **Coupon rate.** This is the interest rate contractually set by the firm. The firm decides with the help of their investment bankers what rate of interest the debt will pay. If you borrow from a bank, the bank and the borrower negotiate the contractual rate. The coupon rate does not usually change over the life of the bond (if the debt is fixed rate), and if it does, it is only because it is written into the contract (e.g., floating rate debt). For example, if debt with a maturity of one year has a face value of $100 and a coupon rate of 10%, then bond holders will receive an interest payment of $10 at the end of the year plus their principal ($100).

(2) **Promised rate**.[8] This rate is not set by the firm; it is set by the market. It is based on the market's assessment of how risky the debt is. The higher the risk of default or the lower the credit rating, the higher the promised rate which the market will demand. The promised rate on the debt changes every time there is new information about the bond's riskiness or the value of the firm's assets. As the market reassesses the probability that the bond will default, they will revise the market price of the debt and thus the promised rate on the debt.[9] For example, if a bond with a face value of $100, a coupon rate of 10%, and a one year maturity sells for $97, then the promised rate is 13.4%.

$$\text{Price} = \frac{\text{Face Value}\left(1+r_{coupon}\right)}{1+r_{promised}} = \frac{100(1+0.10)}{1+r_{promised}} = 97 \qquad (8)$$

$$r_{promised} = \frac{100(1+0.10)}{97} - 1 = 13.4\%$$

[8] Traders usually refer to the yield on a bond. By this, they mean the promised return. I will use promised rate and yield interchangeable. When you calculate or use bond returns, keep track of whether the return is a promised or expected return. If you look up a yield, it is almost always a promised return.

[9] The same logic applies to bank loans, but the market value of bank loans is not always reported or disclosed.

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In most cases, the promised return and coupon rate are the same when the firm issues the debt. In these cases, the bond was issued at par. This means the bond was sold for face value.

(3) **Expected rate of return.** We are going to discount expected cash flow from assets at the expected rate of return on assets. The expected return on assets is a weighted average of the expected return on debt and the expected return on equity. Thus the correct cost of debt is the expected, not the promised, return on debt. The expected return on debt is the average return you earn if you own the debt. It is less than the promised return if the bond might default and pay you less than promised. The promised return is the maximum return you could earn. The more likely the bond is to default and the worse the return in default, the greater the difference between the expected and promised return.[10]

(d) **Cost of equity – Capital Asset Pricing Model (CAPM).** The last number we need is the cost of equity. This is the number we have the most difficulty thinking up a way to measure. Unlike debt, there isn't a stated cost of equity. To answer this question we are going to take the perspective of investors. We want to ask how they perceive the risk of our firm's equity and thus how they determine the rate of return they require to hold our equity. To do this, I am going to have to introduce you to a model of how risk is priced. A model is a simplified description of how the world works. Asset pricing models are financial models that explain what the expected return on assets should be. I will use the Capital Asset Pricing Model (CAPM). It has two advantages. First, it is the most widely used model for calculating the cost of capital. More importantly, the intuition behind the model makes a lot of sense and you can explain it to someone who doesn't understand finance.[11]

(1) **Decomposing realized return.** The return on any asset, including equity, can be divided into three components. The first term is the risk-free return. The second and third terms are the risky parts of the returns.

$$r_{Equity} = r_{riskfree} + \beta_{Equity}\left[r_{market} - r_{riskfree}\right] + \varepsilon \qquad (9)$$

[10] To calculate the expected return of debt, we need more information. We need to know how often the bond pays its promised payment (110) and how often it defaults. We also need to know what the bond is expected to pay in default. Assume the bond defaults 10% of the time and in default, investors receive 80 cents on the dollar or $80 in default. In this case, the expected return is 10.3%, which is below the promised return of 13.4%.

$$r_D = 0.90\left(\frac{110-97}{97}\right) + 0.10\left(\frac{80-97}{97}\right)$$

$$r_D = 0.90(13.4\%) + 0.10(-17.5\%) = 10.3$$

[11] The capital asset pricing model can also be used to calculate a cost of debt (the expected return on debt). Just as there is an equity β, there is a debt β and an asset β.

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Dividing the risky component of the equity return into two parts is done with a regression. When you regress the equity return minus the risk-free rate on the market return minus the risk-free rate, the slope of the line is the β. This is the origin of the name β. The estimation error or residual (how much the actual return differs from the estimated return) is the ε.

(2) **Two types of risk: Definitions.** The risk of an asset can be divided into two sources of risk: systematic and idiosyncratic. The risk of an asset is often measured as the variance of its return.

$$\text{Risk}_{\text{Equity}}\left[r_{\text{Equity}}\right]=0+\beta^2_{\text{Equity}}\,\text{Risk}\left[r_{\text{market}}\right]+\text{Risk}\left[\varepsilon\right]$$
$$\text{Var}\left[r_{\text{Equity}}\right]=0+\beta^2_{\text{Equity}}\,\text{Var}\left[r_{\text{market}}\right]+\text{Var}\left[\varepsilon\right] \quad (10)$$

a) **Systematic risk.** This is also called market risk, economy-wide risk, undiversifiable risk, or priced risk. It isn't necessary that you memorize the different names, but it would be useful that you develop intuition of which risks are systematic. This is the part of the variability in the return which is correlated or related to how well the economy is doing. β measures how the value of this assets grows in booms and shrinks in recessions. Assets that do better than the market in booms and worse in recessions have a β great than one. β is the measure of systematic risk.

b) **Idiosyncratic risk.** This is also called firm-specific risk, unique risk, diversifiable risk, or non-priced risk. This is the part of the risk that is unrelated to (uncorrelated with) how well the economy is doing. This risk is how the economy is divided up. When Coke comes out with a new formula it is either successful or not. Thus Coke is risky. This kind of risk (customer preferences or which products customers purchase) is idiosyncratic. If new Coke is great, Coke wins and Pepsi loses. If new Coke is terrible, Coke loses and Pepsi wins. Changes in market share are often idiosyncratic risk. By purchasing many stocks (in this case Coke and Pepsi), investors can diversify away the idiosyncratic risk. The variance or standard deviation of ε is the measure of idiosyncratic risk.

(3) **Compensation for risk.** The reason we care about risk is it affects our firm's cost of capital. Investors don't like risk. If our projects are riskier, our investors will demand a higher rate of return and our cost of capital will go up. This is the intuition that I want you to consider. Some of what follows

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is math. If you like math, great. If you don't, bear with me. In the end, I would like you to understand the math, but it is equally important to understand the logic behind the math.

a) **Payment for risk: The math.**[12] Although an investment can and, in general will, have both types of risk, only the systematic risk is compensated (priced). By compensated, I mean assets with more systematic risk have higher expected returns – not guaranteed returns – but expected returns. The stock market has more systematic risk than government bonds. Thus stocks are expected to have higher returns, but do not have a higher realized return in every year. Assets with more idiosyncratic risk do not have higher expected returns.

$$E\left[r_{Equity}\right]=r_{riskfree}+\beta_{Equity}\,E\left[r_{market}-r_{riskfree}\right] \tag{11}$$

b) **Payment for risk: The intuition**. Firm specific risk need not be borne by investors. If you are an investor in Coke, and new Coke is a disaster, you lose on your Coke stock. How do you avoid this risk? Selling your Coke stock to someone else just moves the risk from you to them. It doesn't eliminate the risk. Selling some of your Coke stock and investing the proceeds in Pepsi stock eliminates the risk. What if consumers become health conscious and want to avoid soda pop? How do you avoid bearing this risk? The ultimate portfolio is you hold all companies or stocks so that no matter whom customers buy from, they buy from you. When investors diversify, no investor bears the idiosyncratic risk. If investors do not bear idiosyncratic risk, investors cannot demand compensation for idiosyncratic risk. Once you own all firms, you still have a risky portfolio. How do you avoid bearing this risk? An individual can avoid it only by selling the portfolio of risky assets to someone else. An individual can avoid the risk, but it is impossible for every individual to avoid systematic risk. Someone in the economy must own the risky assets and thus bear the systematic risk. We must bribe that person to do so in the form of higher expected return. This is the risk premium for bearing systematic risk. You will often hear that investors do not get paid (compensated) for bearing idiosyncratic risk. This is a conclusion not an assumption. If investors are well diversified, they do not get

[12] ε is the residual in the regression equation. The expected value of ε is zero.

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compensated for bearing idiosyncratic risk because they don't bear idiosyncratic risk.

(4) **Equity discount rate.** To calculate the equity discount rate, you need three numbers: the risk-free rate, the equity beta, and the market price of risk (the expected excess return on the market over the risk-free rate). You can also calculate the debt discount rate this way. The only incremental number you need is the debt beta. The risk-free rate comes from the term structure of government bond rates (if you are in a country where assuming default risk is essentially zero). The market price of

$$E\left[r_{equity}\right] = r_{risk\text{-}free} + \beta_{equity} E\left[r_{market} - r_{risk=free}\right] \quad (12)$$

$$E\left[r_{debt}\right] = r_{risk\text{-}free} + \beta_{debt} E\left[r_{market} - r_{risk=free}\right]$$

B) **Real Options.** When valuing a project using discounted cash flow, we are deciding whether to invest in the project or not. There is one decision and it occurs today. This method is correct, but in some situations it is incomplete. There are some projects that contain embedded flexibility. You can choose to make investment decisions in the future. Any time you (1) make a decision in the future, (2) based on information you will have in the future (3) but do not have today, that is a real option. These projects are options on real assets (thus the name). The logic you learned about financial options therefore applies here. Examples of future investment decisions (real options) are changes in scale (expanding or shutting down the project), changes in input costs, changes in product design, as well as the timing of the project (do you invest today or do you wait). As with financial options, real options have several components that go into the decision and thus valuation.[13]

1) **Value of the underlying asset.** Real options allow you to invest in a project in the future. Thus you must estimate the future value of the project at the time you make the future decision. Since information will be revealed in the future, there is not one possibly future, but many. Thus you need to estimate the distribution of future values of the project (see below).

2) **Strike price.** When you exercise an option, you pay the strike price. When you exercise a real option you usually make an additional investment. This is equivalent to a strike price.

3) **Value of flexibility: Volatility.** Options have value because you are able to make a decision after you learn information. Thus a key ingredient in a real options valuation is estimating the variability of what you might learn between now and when you make the next investment decision. With a DCF, we estimate the expected value of the cash flows (and the expected future value of the project). With a real options valuation, you must estimate all the future possible values of the project at the time you make the next investment (e.g. spend the strike price). This can be done by specifying all

[13] In theory, all six parameters of financial options valuation (Black-Scholes) are present in a real option. I will discuss only a few here. The other parameters which you should consider are the maturity of the option (how long before you have to make the investment decision), the risk-free rate, and the dividend yield (how much of today's value of the assets is cash flows that will be generated before you invest and thus you are not entitled to.

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possible future values (and probabilities) or by specifying the future expected value (the mean), the volatility of this value (the standard deviation), and the shape of the distribution of future values.[14]

C) **Multiples.** The third approach to valuation is a multiples analysis. It is also called a comparable analysis, since you estimate the value of the firm you are trying to value by comparing it to other comparable firms whose value you already know. There are two steps to a multiples valuation

1) **Choosing the multiple.** To value a firm using multiples, you first need to choose a multiple for comparison. This is a ratio of the value of the comparable firms to a valuation metric.

(a) **Numerator [measure of value].** There are two choices for the numerator of the valuation ratio: asset value and equity value. The advantage of using the asset value is the comparable firms do not have to have the same leverage as the target firm. If you use an equity value in the numerator, then the comparable firms must have similar leverage to the firm you are valuing.

(b) **Denominator [valuation metric].** Common choices for valuation metrics are sales revenues, net income, and cash flow from assets. The advantage of focusing on these three is almost any valuation metric that is taken from the income statement or cash flow lies between the price to sales multiple and the price to cash flow from assets multiple.

2) **Choosing comparable firms.** The challenge with a multiples analysis is finding firms that are comparable to the target firm you are trying to value. You can observe the valuation ratio (e.g., price to net income) for comparable firms but not the target firm and you have to assume the ratio is the same. The way to do this is to examine which firm parameters each multiple depends upon. Thus your choice of valuation ratio and comparable firms must be a joint decision. Depending upon which valuation ratio you use, you must assume the comparable firm and the target firm have the same discount rate, growth rate, reinvestment rate (capital efficiency ratio) and profit margin. These are the four fundamental parameters that are embedded in any multiples valuation.

3) **Price versus value.** A multiples analysis is technically a pricing method not a valuation method. The "value" we put in the numerator comes from the market. It is the market price, not a value. The market price is equal to value (multiples is a valuation method) only if markets are efficient (price equals value). Multiples is valuable because it is a pricing technique. Every time you want to purchase or sell a firm you are interested in both its value (from DCF) and its price (from multiples). This is why I think you need both tools in your toolbox.

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[14] With Black-Scholes, you specify the future expected value of the underlying asset when you specify the current value, the risk-free rate, and the dividend yield. You also specify the standard deviation of returns. Black-Scholes assumes the distribution of return on the asset are normally distributed or the future value of the asset is log-normally distributed.

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II) **The Capital Structure Decision**. The second corporate finance question is how the firm should finance its projects. This question asks both what the source of capital should be (e.g., debt or equity) but also how the risk of the firm should be allocated among its investors. Thus the capital structure question includes the question of whether and how a firm should manage its risk. The source of financing seems simple. The firm can issue debt or equity. The challenge is there is an almost infinite variety of securities the firm can issue. The kinds of securities that a firm can issue are limited only by their and their banker's creativity. To be able to answer the capital structure and risk management question we need a way to simplify the question. This is the purpose of the Modigliani and Miller (M&M) theorem. There are only six factors you need to consider (see Figure 3).

A) **Modigliani and Miller Capital Structure Irrelevance Theorem.**[15] First it is worth parsing this label. Modigliani & Miller are the last names of the two professors who developed this theorem. They received the Nobel Prize in economics for their work. Capital structure means we are examining how the firm should be financed. Theorem sounds like this will be an ivory tower, mathematical result that has little relevance for the real world decisions you will face. Irrelevance – this suggests that the capital structure decision doesn't matter. So far this doesn't sound good.

1) **Basic intuition**. The conclusion of the M&M theorem is how a firm finances itself (its capital structure) is irrelevant. Whether a firm finances itself with debt or equity or any other type of security doesn't change the value of the firm or the wealth of its shareholders.[16] This should strike you as insane (if not, please let me know). Thus your initial reaction is this theorem is a waste of your time. Let me convince you that it is not. Figuring out why and when one source of capital is cheaper (better), is extremely complicated. The M&M theorem will allow you to do so. We first listed a set of six assumptions (see below). If these assumptions are true (we are in an M&M world), then capital structure is irrelevant. If you think that capital structure matters, that the correct capital structure can raise the value of the firm, then at least one of the assumptions must be false. The importance of the M&M theorem isn't its conclusions; the importance is the assumptions. It gives you a very short list of why and when capital structure matters. Thus as we go through the assumptions you should be thinking about how a violation of the assumptions would lead to the conclusion that one kind of capital is cheaper (better) than another. This is the power of the theorem.

2) **Modigliani & Miller assumptions.** If these assumptions are true, then changes in the source of capital do not change the value of the firm or the wealth of shareholders. If capital structure changes do affect the value of the firm, then capital structure is relevant, and you can look through the list of assumptions for the one which is causing capital structure to matter. The assumptions are:

(a) **No change in investment policy.** In an M&M world, we assume that the investment policy of the firm is not changed by how the firm

[15] Modigliani, Franco and Merton Miller, "The Cost of Capital, Corporate Finance, and the Theory of Investment, *American Economic Review*, 48 (June, 1958) pp. 261-97.

[16] It is also true that whether a firm hedges and how a firm hedges its risk does not change its value in an M&M world.

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is financed. Thus whether you finance the firm with debt or equity does not change the projects in which the firm invests. Firms take all positive NPV projects and never invest in negative NPV projects. If you do not change this policy, you do not change the assets of the firm, it is very difficult to change the value of the firm. That is why this is the most important of the M&M assumptions.[17]

(b) **No taxes**. If the government taxes payments from the firm more heavily if they come from an equity security than a debt security, then the firm and its investors will prefer to be financed by debt. To make capital structure irrelevant, we need that the total tax on debt cash flows (at the corporate and personal level) and the total tax on equity cash flows (at the corporate and personal level) are equal. In proving the M&M theorem, all tax rates are usually assumed to be zero. In practice, debt financing is often tax favored as the firm may deduct interest payment but not dividend payments.

(c) **No costs of financial distress (CoFD).** An all-equity firm never goes bankrupt. A firm with debt in the capital structure can go bankrupt. If bankruptcy is costly (e.g., legal costs), then adding debt to the capital structure will lower the value of the firm. The bankruptcy costs are more accurately called the costs of financial distress since the formal bankruptcy costs are usually a small fraction of the costs of financial distress. This is a broader term and includes the costs of leverage beyond the legal costs of bankruptcy.

(d) **Perfect capital markets.** There are two parts to this assumption.

(1) **Information is symmetric.** In an M&M world, we assume that managers (insiders) do not know more about the value of the firm, its cash flows, and risks than the market (outsiders). This is a very powerful assumption. It assumes that it is easy and costless to look inside the firm. Obviously, in the real world, this is very difficult (costly) and in some cases impossible. If managers have more information than the market, then their choice of how to finance the firm could reveal the manager's information to the market and alter the value of the firm. We do not need to assume that the managers know the future, but only that they know no more than investors.

(2) **Financial markets are efficient.** An efficient market means the market correctly processes information. In the case of capital structure changes, it means the market understands what an increase in debt opposed to equity implies for the value of the firm and that the price of the firm's securities are equal to the value of the firm's securities. Efficient

[17] If a firm that is financed with debt invested in negative NPV projects, whereas an all equity firm would never invest in negative NPV projects, then capital structure is relevant. If a firm that is financed with debt does not invest in a positive NPV project, whereas an all equity firm would always invest in positive NPV projects, then capital structure is relevant.

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markets also mean that securities are correctly priced. It means the price of a security is equal to its value. In an efficient market, security issues (and repurchases) are zero NPV investments.

(e) **No transaction costs.** If the transactions costs of issuing debt were less than the transactions costs of equity, firms could create value by financing themselves with debt opposed to equity, as it would be cheaper. Thus for capital structure to be irrelevant we have to assume the transactions costs on all forms of capital are equal, and in derivations of the M&M theorem, we assume the transactions costs are zero. Transactions costs include the costs of disbursing dividends or interest payments as well as the investment banking fees for issuing debt or equity.

(f) **Managers maximize shareholder's wealth**. M&M assumes that the objective of managers is to make shareholders wealthy. If this wasn't true, they could choose capital structures which might not be optimal for shareholders, but would be preferable for the managers. In an M&M world, we assume that the interests of managers and shareholders are aligned. There are no incentive problems.

B) **Adjusted Present Value (APV)**. In the first section, I discussed how we value projects. We discount the cash flow from assets at the risk-adjusted asset discount rate. This approach ignores how the firm is actually financed. This valuation approach implicitly assumes capital structure is irrelevant. The value of the firm or project is the same whether the firm is financed with all equity or with some debt and some equity. If capital structure is relevant (if the M&M assumptions are not true in the situation you are analyzing), then we need to adjust our valuation. If capital structure adds or subtracts value, we need to include this adjustment in our valuation of the project. This approach is called adjusted present value. The adjustment is adding the net value of financing.

1) **APV formula.** The value of a project is the value of the project, assuming capital structure is irrelevant (CSI), plus the value of financing. This is the APV formula. The NPV of financing is zero in an M&M world, since capital structure is irrelevant; it doesn't affect the value of the firm.

$$\begin{aligned} \text{NPV}\left[\text{Project}\right] &= \text{NPV}\left[\text{Project}|\text{CSI}\right] + \text{NPV}\left[\text{Financing}\right] \\ &= \text{NPV}\left[\text{Project}|\text{CSI}\right] \\ &\quad + \text{NPV}\left[\text{Tax Shields}\right] \\ &\quad - \text{NPV}\left[\text{Costs of Fin Distress}\right] \\ &\quad + \text{NPV}\left[\text{Miss pricing}\right] \\ &\quad - \text{NPV}[\text{Transaction costs}] \end{aligned} \tag{13}$$

2) **Value of financing.** The second term in the APV formula measures the ways in which capital structure can add or subtract value. If levering up a firm creates value then the NPV[financing] will be positive. If levering up a firm destroys value then the NPV[financing] will be negative. If some debt is good, and too much debt is bad, then the NPV[financing] will first rise

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with leverage and then fall. The leverage that maximizing the NPV[financing], which also maximizes the value of the firm, is the optimal amount of leverage. The NPV[financing] term can be broken down into a term for each M&M assumption. Thus the last step of answering the capital structure question is examining the different ways in which the M&M assumptions can fail and thus make capital structure relevant.

(a) **Tax shield.** In most of the countries in which you operate, interest is a tax-deductible expense, dividends are not. Thus if the firm issues a security called debt, which pays a cash flow called interest, it reduces the firm's taxes. If the firm issues a security called equity, which pays a cash flow called dividends, it does not reduce the firm's taxes. Thus financing a firm with debt raises the value of the firm by the interest rate tax shield. To value the interest rate tax shield, we use the same DCF approach that we use to value almost everything. Thus we need two sets of numbers to calculate the value of the tax shield.

(1) **Expected tax savings**. By issuing debt, the firm expects to make interest payments over the life of the loan. The expected interest payments will lower its taxable income and thus lower its expected tax payments. Notice that the cash flows we want are the expected tax payments, which depend upon the expected interest rate, not the promised rate.

(2) **Risk-adjusted discount rate**. The correct discount rate is the one that accounts for the systematic risk of the expected tax savings. When the firm pays interest, they save taxes. When they don't pay interest (e.g., they default on their debt), they pay less interest and save less on taxes. Thus the systematic risk of the tax shield is derived from the systematic risk of the debt.[18]

(3) **Perpetuity formula.** The value of the tax shield is the discounted value of the expected tax savings. In situations where the debt is expected to be outstanding in perpetuity, this formula simplifies to the corporate tax rate times the value of the debt. This is an expression you will often see in valuation spreadsheets. This formula is correct, only if the debt is expected to be outstanding in perpetuity. This is a very strong assumption. It assumes that after a firm defaults, the same level of debt will be reissued, which I find unlikely.

$$\text{NPV}\left[\text{Tax Shield}\right]=\sum_{t=1}^{\infty}\frac{E\left[\text{Tax savings}_t\right]}{\left(1+r_{TS}\right)^t}=\sum_{t=1}^{\infty}\frac{\tau_{corp}r_D D}{\left(1+r_D\right)^t}=\tau^{corp}D \quad (14)$$

(b) **Costs of financial distress (CoFD)**. As a firm increases its leverage,

[18] The tax shield may also have systematic risk due to tax rate risk. If the corporate tax rate systematically rises or falls in recessions, this would cause the correct discount rate for the tax shield (r_{TS}) to differ from the discount rate for debt (r_D). The data I have seen suggests that the systematic risk of the corporate tax rate in the US is zero (if you are interest in seeing these numbers let me know). Thus I recommend using r_D as the discount rate for the tax shield.

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it saves more taxes. This is good. However, it also increases the probability that the firm will go bankrupt and thus pay the legal costs of bankruptcy. However, if you figure out the magnitude of these legal costs, they are quite small and thus can't explain why firms are not all highly levered. This is why we use the term costs of financial distress instead of bankruptcy costs. Economic distress occurs when something bad happens to a firm. Its cash flows fall because of an economy-wide recession or firm-specific reasons and this lowers the value of the firm's assets. The fall in firm value due to economic distress happen to an all equity firm and to a levered firm. Thus the economic distress costs are not relevant to the leverage decision. They are not a marginal cost of leverage. The costs of financial distress are the additional costs that a firm experiences, on top of economic distress costs, because they have debt in the capital structure. These costs are hard to measure but are still very important in determining how much debt a firm should have.[19]

(c) **Mispriced securities**. In an efficient market, securities are always correctly priced. Thus the NPV of a debt issue is zero. If the firm sells a \$10M of debt, it receives \$10M of cash and gives away a security with \$10M. If the firm sells a \$10M of equity, it receives
\$10M of cash and gives away a security with \$10M. Both transactions have a zero NPV in an M&M world. However, if managers know information that the market does not know, the market can over or under estimate the value of the firm's debt and equity. This means the market may overpay for securities (in which case the issue is a positive NPV from the firm's perspective) or underpay for securities (in which case the issue is a negative NPV from the firm's perspective). Thus another term in the NPV[financing] expression is the mispricing of the security issue.

$$NPV\left[\text{Mispricing}\right] = P_{Security} - V_{Security} \tag{15}$$

(d) **Transactions costs**. Including the transactions costs are straight forward. When issuing securities or borrowing from the bank, the bank or the underwriter will tell you how much it will cost or you should ask. These costs should be included in your calculations.

3) **Comparing different financing options.** In many cases, a firm has multiple options for how to finance its investments. To decide which option is best, we calculate the APV (equation 13) for each option. There is a simpler approach. We know the value of the project, assuming capital structure is irrelevant (e.g. NPV[Project|CSI]) is the same across all of the different financing options. Thus, we only need to compare the NPV[financing] for each option and see which one adds the most value or subtracts the least value. By examining each of the terms in the

[19] There are several source of financial distress costs. They included investment distortions. If the capital structure causes the firm to take negative NPV project or prevents it from taking positive NPV projects this is a cost of financial distress. Financial distress costs also arise when the relationships with the firm's suppliers, employees, and customers are disrupted by the presence of debt and the possibility of economic distress.

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NPV[financing], it becomes obvious whether the advantage of one financing method over another comes from the tax advantage, the lower costs of financial distress, the more favorable pricing, or the lower transactions costs. It can also suggest a financing option that we had not considered which would be even better than the ones we are considering.

III) **The Dividend (Payout) Decision**. This is the third and final corporate finance question. Once you understand the investment decision and the capital structure decision, there is little to add for the dividend decision. In an M&M world, the dividend decision is irrelevant. Thus there are only five reasons the dividend decision matters (the M&M capital structure assumptions excluding the no costs of financial distress assumption). There are two components to the dividend (or the payout) decision.

A) **Decision to Return Capital.** The decision of whether to return capital is really the investment decision. Remember, if the NPV of the firm's project is positive, this means the expected return on the project is higher than what our capital providers can earn on projects of equivalent risk. If the NPV is positive, the firm can create more value than the shareholders can with the same capital. In this case, the firm should keep the cash and invest it on behalf of the firm's investors. If the NPV of the project is negative, this means the expected return on the project is lower than what our capital providers can earn on projects of equivalent risk. If the NPV is negative, the firm destroys value by investing the capital for their shareholders. In this case, the firm should return the cash to the firm's investors so they can invest it themselves.[20]

B) **How to Return Capital.** Once the firm has decided that it makes sense to return the capital to its shareholders, the question is how to do this. Should they pay a dividend or repurchase stock. The same M&M logic we used for capital structure can be used for dividend policy. If the M&M assumptions are true, it doesn't matter how the capital is returned (or whether the capital is returned). Thus if you think that returning capital, or not returning capital, or the method of returning capital matters, at least one of the M&M assumptions must be false. Go figure out which one and thus why a change in dividend policy creates or destroys value.

[20] This is true only in an M&M world. In the real world, a firm which does not currently have positive NPV projects may retain cash for the future. In the future it might have projects arrive and be unable to access the capital markets to fund them (see capital structure irrelevance). In this case, having cash on the balance sheet can create value.

Figure 1: The Three Corporate Finance Questions

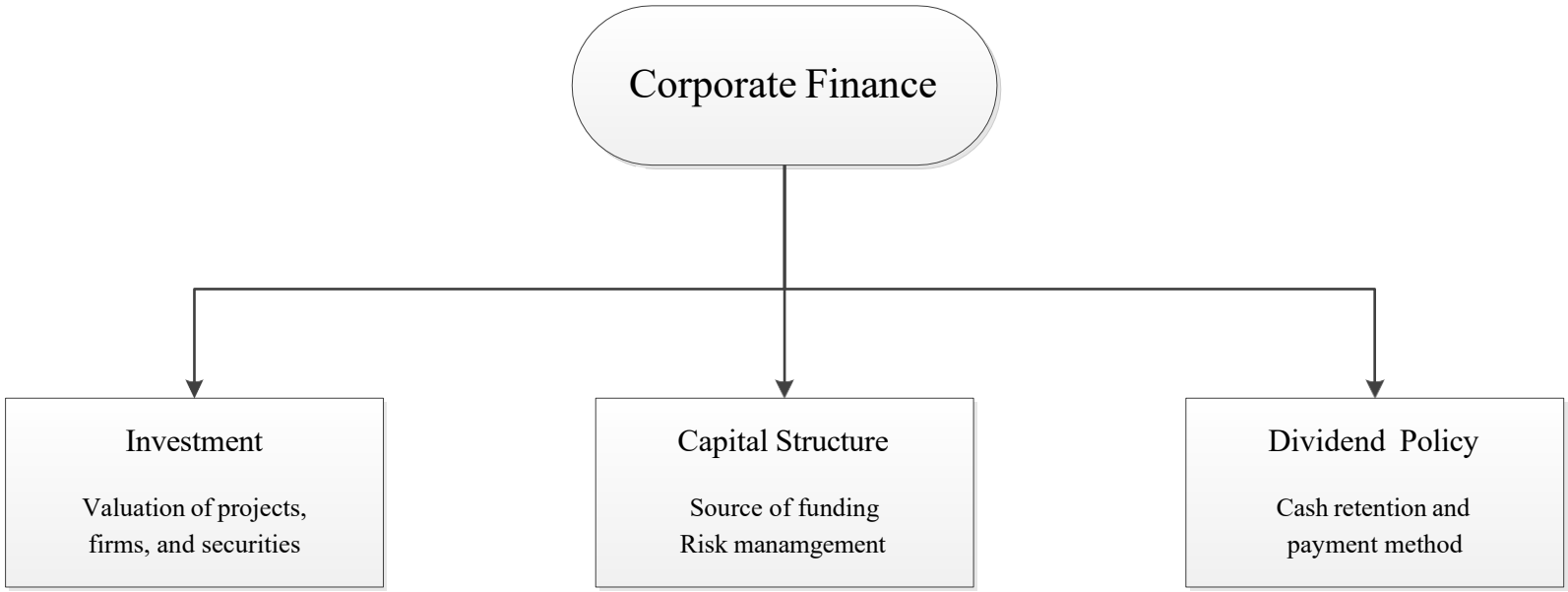


Figure 2: The Investment Decision

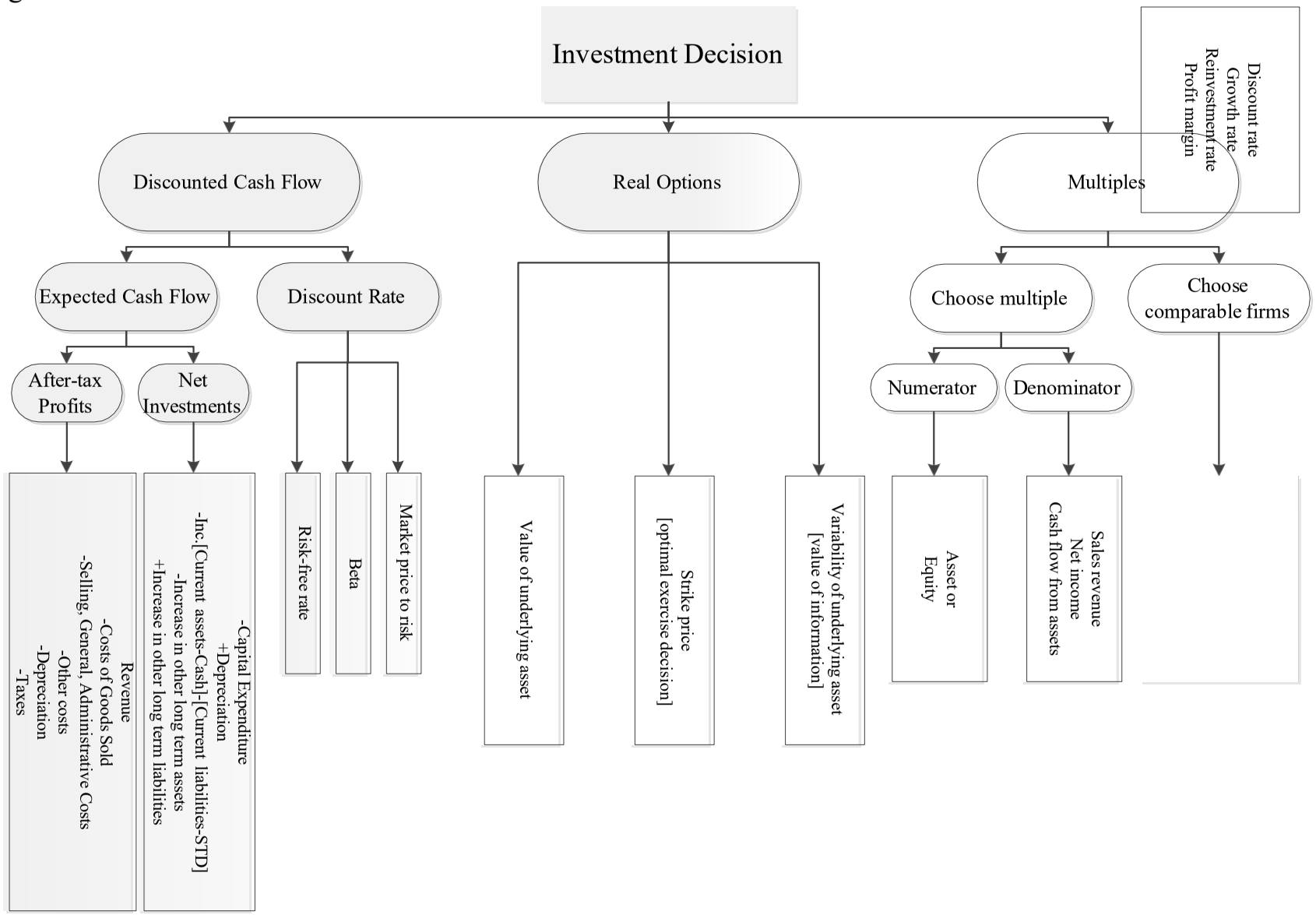
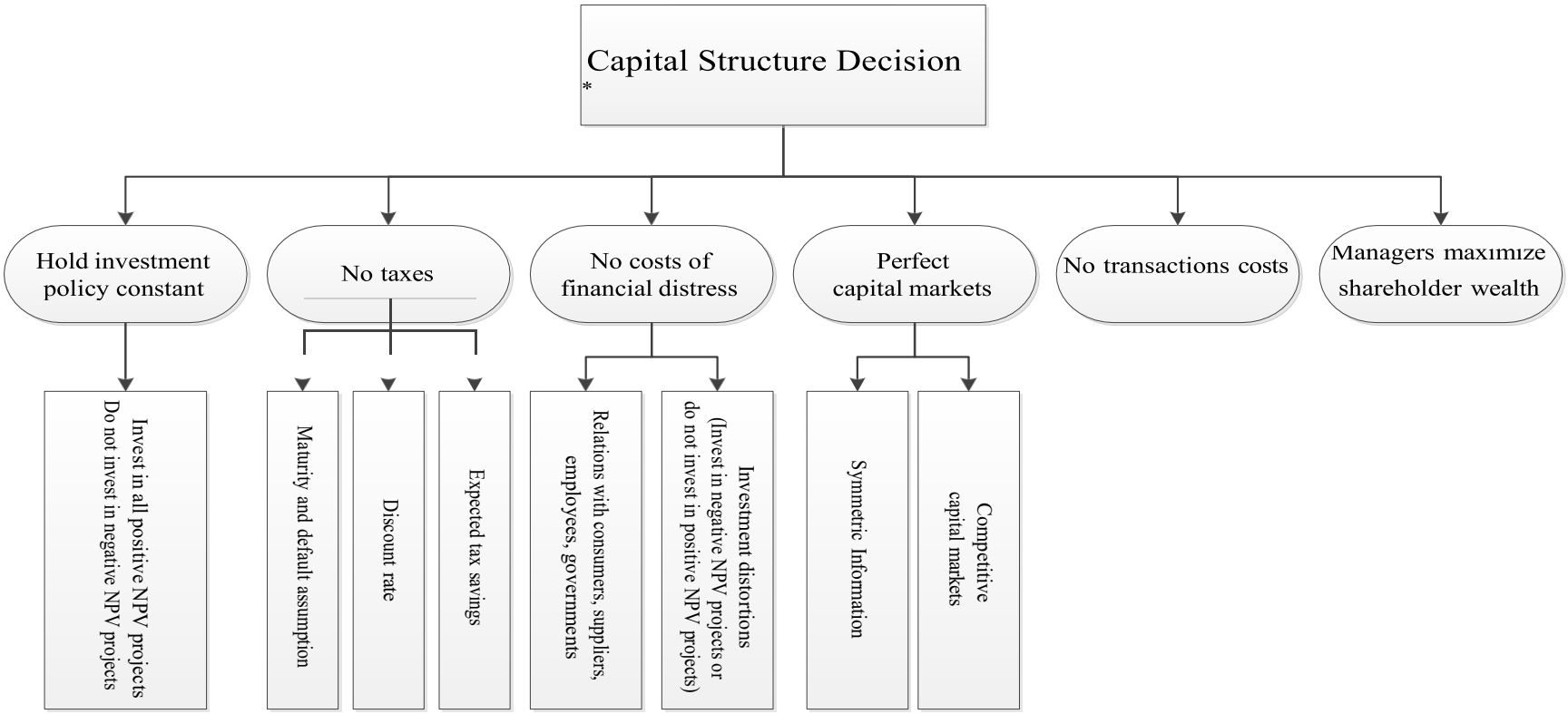


Figure 3: The Capital Structure Decision



* The relevance of the capital structure decision, the risk-management decision, the dividend decision (how to pay cash out of the firm as well as how much cash to retain) are all based on the assumptions of M&M. Thus there are only six factors you need to consider and discuss for each of these decisions (five for the dividend decision).