Fundamentals of Accounting and Finance (JRE 300)

Finance Lecture #5: Corporate Finance

Contents

1 Introduction

In the previous lecture, we developed the tools for understanding how companies should evaluate investment projects. We learned that value is created when projects have positive NPV—when the present value of cash flows exceeds the cost of investment. We also learned how to find the appropriate discount rate by measuring systematic risk through beta and applying the CAPM. For companies funded with both debt and equity, we computed the Weighted Average Cost of Capital (WACC) as a blend of the cost of equity and the after-tax cost of debt.

This lecture tackles a closely related but distinct question: *How should companies finance their operations?* More specifically, how should they choose between debt and equity? This is the question of **capital structure**—the mix of debt and equity a firm uses to fund its assets. At first glance, financing decisions might seem separate from investment decisions, but they're actually deeply connected. The financing mix affects the cost of capital, which determines which projects have positive NPV. Financing choices also affect risk distribution. When a firm adds debt, it commits to fixed payments, which amplifies the volatility of cash flows to equity holders and increases their systematic risk exposure.

The lecture is organized into four parts. We begin with a frictionless benchmark where capital structure is irrelevant to firm value. This might seem like a strange starting point—if capital structure doesn't matter, why study it? The answer is that understanding the irrelevance result tells us precisely *where* to look for explanations of why capital structure matters in practice. Any departure from this baseline must be traced to specific market frictions.

Next, we introduce two critical real-world frictions: corporate taxes and bankruptcy costs. These frictions push in opposite directions. Taxes make debt attractive because interest payments are tax-deductible, creating a valuable interest tax shield. Bankruptcy costs make excessive debt dangerous because they can destroy firm value through both direct legal costs and indirect costs of financial distress. The optimal capital structure balances these forces. We'll see that this optimum depends crucially on the firm's systematic risk and show how corporate tax policy affects not just individual firms but the stability of equity markets economy-wide.

We then connect capital structure to central banks and monetary policy. At this point in our course, we have in place the framework to understand why adjusting interest rates is such an effective tool for managing economic growth. When a central bank raises its policy rate, it increases the cost of capital throughout the economy, shrinking the set of positive-NPV investments and reducing capital spending, employment, and growth. This is the real channel of monetary policy, operating directly through the corporate finance decisions we study.

Lastly, we preview hedging and derivatives. Firms face many risks beyond systematic market exposure—commodity prices, foreign exchange rates, weather. While shareholders can diversify away firm-specific risks by holding broad portfolios, individual firms may still want to manage specific exposures that affect their operations. Options and other derivatives provide tools for this risk management that would be impossible with stocks and bonds alone.

2 Capital Structure: Frictionless Benchmark

When a firm is financed entirely with equity, valuing it is straightforward. Its value equals its market capitalization—the stock price multiplied by shares outstanding. This market cap represents the present value of all future cash flows the firm will generate, because equity holders are the sole claimants to those cash flows.

But most firms don't finance themselves entirely with equity. They issue debt as well, creating bondholders who have claims on the firm's cash flows in the form of interest and principal payments. When a firm has both debt and equity outstanding, its market capitalization no longer captures total firm value. The market cap measures only what equity holders can claim. We must add the market value of debt—what the bonds trade for—to measure the firm's complete worth. This gives us the fundamental valuation identity: $V = E + D$, where V is total firm value, E is the market value of equity, and D is the market value of debt. We sum the present values of cash flows to each group of investors.

This identity raises the central question of capital structure: does the choice between debt and equity financing affect total firm value V? Or does it merely redistribute a fixed total between the two claimant groups? In the frictionless world we examine first—no taxes, no bankruptcy costs, no transaction costs—the answer is striking: financing choices don't affect firm value. Firm value is determined entirely by the cash-generating capacity of the firm's assets and the projects it undertakes. Whether we finance a factory with debt or equity doesn't change how many goods it produces or what customers pay for them. Value comes from positive-NPV projects, not from financing decisions.

The intuition is simple but profound. Debt is cheaper than equity ($r_D < r_E$) because it's less risky—bondholders receive fixed payments and get paid first if the firm fails. This might suggest that using more debt would lower the firm's overall cost of capital and increase value. But this overlooks a crucial offsetting force. When a firm adds debt, its equity becomes riskier because equity holders now have a residual claim—they get paid only after bondholders receive their contractual payments. As debt increases, equity holders bear more systematic risk and demand a higher expected return to compensate. The cost of equity equilibrates according to the debt level. These forces exactly offset each other, leaving the weighted average cost of capital constant regardless of how the firm splits financing between debt and equity.

This irrelevance result matters not because we think the real world is frictionless—it plainly isn't—but because it establishes a baseline. Understanding why financing doesn't matter in a perfect world tells us exactly where to look for deviations in practice: taxes, bankruptcy costs, agency problems, asymmetric information, and other frictions. Every theory of optimal capital structure is fundamentally a story about which specific frictions create departures from this benchmark.

2.1 How Leverage Affects Equity Risk

While capital structure doesn't affect total firm value in the frictionless world, it profoundly affects the distribution of risk. To see this, we need to understand the different nature of debt and equity claims. Debt holders have a **fixed claim** on the firm's cash flows. They're promised a specified interest rate and principal repayment, and as long as the firm can make these payments, the debt holders receive exactly what they were promised—no more, no less. Their payoff doesn't depend on how well the business performs beyond the threshold of being able to service the debt.

Equity holders, by contrast, have a **residual claim**. They receive whatever remains after all other obligations—debt payments, wages, supplier payments, taxes—have been met. This residual nature creates an amplification effect. Consider a firm whose assets are worth \$1,000, financed with \$400 of debt promising 5% interest and \$600 of equity. If the firm performs well and asset value rises 20% to \$1,200, debt holders still receive only their promised \$400 (plus interest). The gain flows entirely to equity, which rises from \$600 to \$800—a 33% increase. Conversely, if asset value falls 20% to \$800, equity falls to \$400—a 33% decline. The asset volatility of $\pm 20\%$ translates into equity volatility of $\pm 33\%$. Leverage amplifies returns.

Critically, leverage amplifies *systematic* risk, not just total volatility. The reason is that debt creates a fixed obligation that must be met regardless of economic conditions. In good times, when the economy is strong and cash flows are robust, meeting debt payments is easy and equity captures most of the upside. But in bad times—during recessions or systematic downturns—the fixed obligation becomes burdensome. Cash flows may barely cover debt service, leaving little for equity. The equity holders bear the full force of systematic shocks, their returns magnified relative to the firm's underlying systematic risk exposure.

We can formalize this intuition using beta, our measure of systematic risk. The firm's overall systematic risk is captured by its **project beta** β_{Project}, which measures how sensitive the firm's total asset returns are to market movements. This project beta depends only on the nature of the firm's business—what industry it's in, how cyclical its revenues are—and is independent of how the firm is financed. But the **equity beta** β_E does depend on leverage.

$$\beta_{\text{Project}} = \frac{E}{E+D}\beta_E + \frac{D}{E+D}\beta_D$$

This says the project beta is a value-weighted average of the equity beta and debt beta. Solving for the equity beta yields:

$$\beta_E = \beta_{\text{Project}} + \frac{D}{E}(\beta_{\text{Project}} - \beta_D)$$

This is the fundamental equation relating leverage to equity risk. It decomposes equity beta into two parts: the project beta (reflecting the underlying business risk) and a leverage premium that depends on the debt-to-equity ratio and the spread between project and debt betas. When debt is risk-free—when $\beta_D = 0$—this simplifies to $\beta_E = \beta_{\text{Project}}(1 + D/E)$. But even when debt carries some systematic risk, the intuition holds: more leverage means higher equity beta.

2.2 Leverage and the Cost of Equity

Higher systematic risk demands higher expected returns. Through CAPM, we can translate the leverage effect on beta into a statement about required returns. Recall that CAPM relates an asset's required return to its systematic risk:

$$r_E = r_f + \beta_E(\mathbb{E}[R_m] - r_f)$$

where r_f is the risk-free rate and $\mathbb{E}[R_m] - r_f$ is the market risk premium. For an all-equity firm—one with no debt—the required return would be:

$$r_0 = r_f + \beta_{\text{Project}}(\mathbb{E}[R_m] - r_f)$$

This r_0 represents the **unlevered cost of equity**, the return required if the firm used no debt financing.

Similarly, the cost of debt reflects the debt's systematic risk:

$$r_D = r_f + \beta_D(\mathbb{E}[R_m] - r_f)$$

Now we can substitute our expression for β_E into the CAPM formula for equity to derive how leverage affects the cost of equity. Starting with CAPM:

$$\begin{aligned}
r_E &= r_f + \beta_E \times (\mathbb{E}[R_m] - r_f) \\
&= r_f + \left[\beta_{\text{Project}} + \frac{D}{E}(\beta_{\text{Project}} - \beta_D)\right] \times (\mathbb{E}[R_m] - r_f) \\
&= r_f + \beta_{\text{Project}} \times (\mathbb{E}[R_m] - r_f) + \frac{D}{E}(\beta_{\text{Project}} - \beta_D) \times (\mathbb{E}[R_m] - r_f) \\
&= r_0 + \frac{D}{E}\left[\beta_{\text{Project}} \times (\mathbb{E}[R_m] - r_f) - \beta_D \times (\mathbb{E}[R_m] - r_f)\right] \\
&= r_0 + \frac{D}{E}\left[(r_0 - r_f) - (r_D - r_f)\right] \\
&= r_0 + (r_0 - r_D)\frac{D}{E}
\end{aligned}$$

We can express this relationship with its interpretation:

$$\underbrace{r_E}_{\text{Levered cost of equity}} = \underbrace{r_0}_{\text{Unlevered cost of equity}} + \underbrace{(r_0 - r_D) \times \frac{D}{E}}_{\text{Leverage premium}}$$

This is one of the most important relationships in corporate finance: the cost of equity rises linearly with leverage. We can interpret this as: the levered cost of equity equals the unlevered cost plus a leverage premium. The leverage premium $(r_0 - r_D) \times D/E$ compensates equity holders for bearing amplified systematic risk. The larger the debt-to-equity ratio, the more systematic risk equity holders bear, and the higher the return they demand.

Notice that the slope of this relationship is $r_0 - r_D$, the difference between the unlevered cost of equity and the cost of debt. This spread represents the risk premium associated with being an equity holder rather than a debt holder in the unlevered firm. When you add leverage, this spread gets multiplied by the debt-to-equity ratio, capturing how the residual claim amplifies risk.

2.3 WACC Invariance

We've just shown that leverage increases the cost of equity. This might lead you to think the firm's overall cost of capital might increase with leverage. Remarkably, this is wrong. In the frictionless world, the firm's weighted average cost of capital stays constant regardless of the capital structure.

To see this, recall that WACC is defined as the value-weighted average of the costs of equity and debt:

$$\text{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D} r_D$$

Now substitute our expression for r_E:

$$\begin{aligned}
\text{WACC} &= \frac{E}{E+D}\left[r_0 + (r_0 - r_D)\frac{D}{E}\right] + \frac{D}{E+D} r_D \\
&= \frac{E}{E+D} r_0 + \frac{D}{E+D}(r_0 - r_D) + \frac{D}{E+D} r_D \\
&= \frac{E}{E+D} r_0 + \frac{D}{E+D} r_0 = r_0
\end{aligned}$$

The WACC equals r_0, the unlevered cost of equity, regardless of how much debt the firm uses. This is remarkable: even though the cost of equity increases with leverage, and even though we're putting more weight on debt which has a different cost, the weighted average remains constant.

The intuition is that we're facing two offsetting effects. As leverage increases, each dollar of equity becomes riskier and more expensive. But we're using fewer dollars of expensive equity and more dollars of cheaper debt. In a frictionless world, these forces exactly cancel. The firm's overall cost of capital depends only on the systematic risk of its assets, not on how those assets are financed. This relationship is visualized in Figure 1. Since firm value equals the present value of cash flows discounted at WACC, and since WACC is constant across capital structures, firm value must also be constant across capital structures. The financing decision just reshuffles claims to a fixed pie without changing the pie's size.

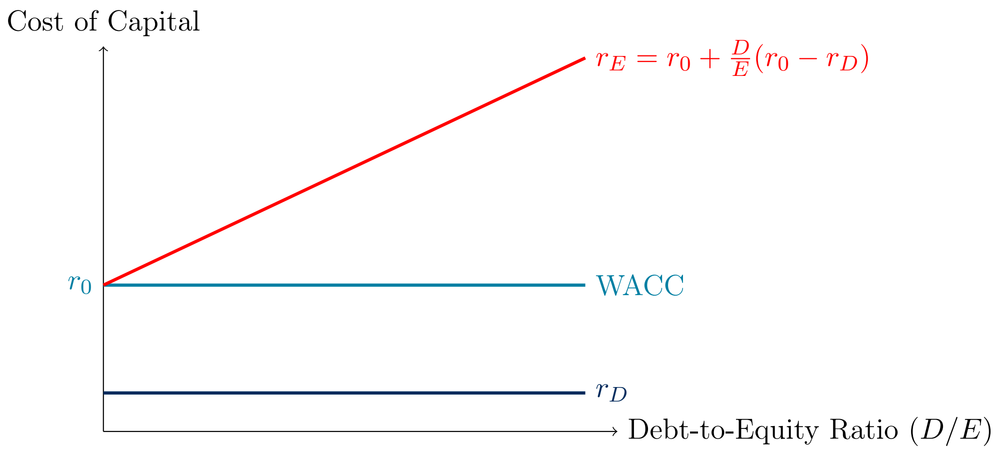


Figure 1: Cost of equity rises with leverage, but WACC stays constant

3 Capital Structure: Taxes, Bankruptcy, and Other Frictions

The irrelevance result holds in a frictionless world. But the real world is far from frictionless. Two frictions in particular have first-order effects on optimal capital structure: corporate taxes and bankruptcy costs. These frictions push in opposite directions, and the optimal capital structure balances them.

3.1 The Interest Tax Shield

Most countries' tax systems treat debt and equity financing asymmetrically. Interest payments on debt are tax-deductible for corporations, while dividend payments to equity holders are not. This creates a fundamental advantage for debt financing.

To see the effect, consider a firm earning \$100 in EBIT (earnings before interest and taxes). If the firm is all-equity and the corporate tax rate is $\tau_c = 25\%$, the firm pays \$25 in taxes and distributes \$75 to shareholders. Now suppose the firm instead has \$500 of debt at 5% interest, requiring \$25 in annual interest payments. The firm's taxable income is now \$75 (EBIT minus interest), so taxes are $0.25 \times 75 = \$18.75$. Total cash flows to investors are \$25 to debt holders plus $75 - 18.75 = \$56.25$ to equity holders, totaling \$81.25. This is \$6.25 more than the all-equity case. The difference—the corporate tax rate times the interest payment—is called the **interest tax shield**.

The tax shield arises because interest is deducted before computing taxes, effectively making the government a silent partner who absorbs part of the cost of debt financing. For every dollar of interest paid, the firm's tax bill falls by τ_c dollars. This makes the *after-tax* cost of debt equal to $r_D(1-\tau_c)$, which is less than the pre-tax cost r_D.

3.2 Cost of Equity with Taxes

The existence of the tax shield changes the leverage relationship for equity beta. Without taxes, we had:

$$\beta_E = \beta_{\text{Project}} + \frac{D}{E}(\beta_{\text{Project}} - \beta_D)$$

With taxes, the effective leverage is lower because of the tax shield. The equity beta relationship becomes:

$$\beta_E = \beta_{\text{Project}} + \frac{D}{E}(\beta_{\text{Project}} - \beta_D)(1-\tau_c)$$

The $(1-\tau_c)$ term captures how the tax shield reduces equity holders' systematic risk exposure. For any given debt-to-equity ratio, equity beta is lower with taxes than without because the tax shield cushions equity holders from some of the risk that leverage would otherwise impose.

Using CAPM with the adjusted equity beta, we can derive the cost of equity in the presence of taxes. Starting from CAPM:

$$\begin{aligned}
r_E &= r_f + \beta_E \times (\mathbb{E}[R_m] - r_f) \\
&= r_f + \left[\beta_{\text{Project}} + \frac{D}{E}(\beta_{\text{Project}} - \beta_D)(1-\tau_c)\right] \times (\mathbb{E}[R_m] - r_f) \\
&= r_0 + \frac{D}{E}(r_0 - r_D)(1-\tau_c)
\end{aligned}$$

The leverage premium is smaller with taxes than without. The tax shield reduces the additional return equity holders demand to compensate for bearing amplified systematic risk.

3.3 WACC with Taxes

The tax shield modifies the WACC formula. The effective after-tax cost of debt is $r_D(1-\tau_c)$, so:

$$\text{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D} r_D(1-\tau_c)$$

Now we substitute our expression for $r_E = r_0 + (r_0 - r_D) \times \frac{D}{E} \times (1-\tau_c)$ and simplify:

$$\begin{aligned}
\text{WACC} &= \frac{E}{E+D} \times r_E + \frac{D}{E+D} \times r_D \times (1-\tau_c) \\
&= \frac{E}{E+D} \times \left[r_0 + (r_0 - r_D) \times \frac{D}{E} \times (1-\tau_c) \right] + \frac{D}{E+D} \times r_D \times (1-\tau_c) \\
&= r_0 \times \left[1 - \frac{D}{E+D} \times \tau_c \right]
\end{aligned}$$

Unlike the frictionless case, WACC now *decreases* with leverage. Each additional dollar of debt reduces WACC by a factor proportional to the tax rate. This has profound implications. A lower WACC means higher firm value (since we're discounting at a lower rate) and more positive-NPV investment opportunities (since projects that were marginal at the old WACC now clear the hurdle).

This explains why firms use debt despite its risk-amplifying effects. The tax shield makes debt financing attractive enough to overcome the increased equity risk. From a social welfare perspective, the tax deductibility of interest creates a distortion, encouraging firms to use more debt than would be optimal absent taxes. This relationship is visualized in Figure 2.

3.4 Corporate Tax Policy and Equity Market Stability

The $(1-\tau_c)$ term in the equity beta formula has interesting macroeconomic implications. Higher corporate tax rates act as automatic stabilizers for equity markets. When τ_c is large, the dampening effect on equity beta is strong, making levered equity less sensitive to systematic shocks. Conversely, when corporate tax rates are low, $(1-\tau_c)$ is closer to one, amplifying the leverage effect on systematic risk.

Consider the United States versus Canada: corporate tax rates are higher in Canada than in the U.S. All else equal, this means U.S. firms' equity has higher systematic risk for any given debt-to-

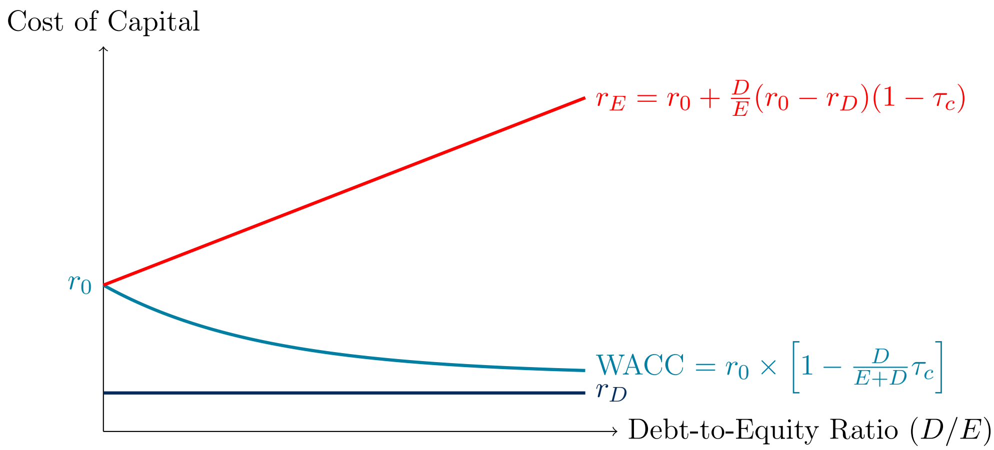


Figure 2: Cost of equity rises with leverage, WACC falls due to tax shield

equity ratio. The U.S. equity market should exhibit greater volatility and higher expected returns due to the greater exposure to systematic risk. This is indeed what we see historically, though it wouldn't be exactly precise to attribute this all exactly to differences in corporate tax rates (there is too much other interesting policy going on!).

This matters beyond just stock returns. Higher equity market volatility affects wealth inequality, since equity ownership is concentrated among wealthier households. It affects retirement security, since pension funds and other retirement accounts hold substantial equity positions. It affects the cost of capital and thus firms' ability to fund risky projects. Corporate tax policy isn't just about revenue collection or business incentives—it fundamentally reshapes the distribution of systematic risk across the economy.

3.5 Bankruptcy Costs: The Counterweight to Tax Benefits

If the tax shield is so valuable, why don't firms finance entirely with debt? The answer lies in the costs and risks associated with high leverage. As debt increases, so does the probability of **financial distress**—the inability to meet debt obligations when they come due.

It's crucial to understand what bankruptcy actually is. A common misconception equates bankruptcy with business failure and shutdown. In reality, bankruptcy is a legal process for handling financial distress: when available cash is insufficient to repay interest obligations. It comes in two main forms. In a **reorganization** (Chapter 11 in the United States), the firm continues operating while renegotiating its debts under court supervision, often emerging with a restructured capital structure where some debt has been converted to equity. In a **liquidation** (Chapter 7), the firm ceases operations and its assets are sold to pay creditors. For large corporations, reorganization is far more common than liquidation.

The costs of bankruptcy fall into two categories. **Direct costs** include legal fees, accounting fees, court costs, and administrative expenses of the bankruptcy process. For large firms, these typically amount to 3-7% of firm value—significant but not catastrophic. Far more damaging are the **indirect costs** of financial distress, which often begin long before formal bankruptcy.

When a firm appears financially troubled, customers become reluctant to purchase, especially for products requiring future service or warranties—who wants to buy a car from a company that might not exist to honor the warranty? Suppliers demand cash payment rather than extending trade credit, straining liquidity. Talented employees leave for more stable employers, taking valuable human capital with them. Banks refuse to lend even for positive-NPV projects, creating **underinvestment** where good opportunities are missed. Assets may need to be sold quickly at fire-sale prices. These indirect costs can dwarf the direct legal costs and may create a self-fulfilling prophecy where the expectation of trouble makes failure more likely.

There's also a more subtle mechanism at work. When market participants perceive higher bankruptcy risk, they demand compensation. Lenders won't lend at the risk-free rate to a firm that might default. Instead, they charge a higher interest rate r_D or equivalently lend at a discount to the face value of bonds. This creates a dangerous feedback loop: more debt raises bankruptcy risk, which raises borrowing costs, which makes debt service harder, which further increases bankruptcy risk. The cost of debt rises endogenously with leverage, accelerating as distress probability increases.

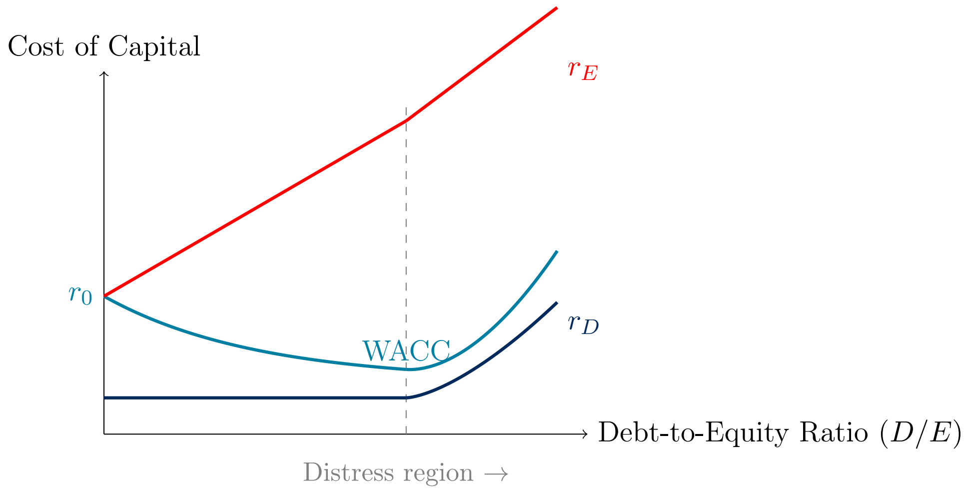


Figure 3: The trade-off theory: tax shield lowers WACC initially, but bankruptcy costs dominate at high leverage

3.6 The Trade-Off Theory

Putting together tax benefits and bankruptcy costs gives us the **trade-off theory of capital structure**. The firm faces an optimization problem:

$$\max_{D/E} \left[\sum_{t=1}^{\infty} \frac{CF_t}{\text{WACC}^t} - \text{PV(Bankruptcy Costs)} \right]$$

subject to the constraint:

$$\text{WACC} = r_0 \left[1 - \frac{D}{E+D} \tau_c \right]$$

As leverage increases, two opposing forces are at work. Higher debt reduces WACC through the tax shield, increasing the present value of cash flows and expanding the set of positive-NPV projects. But higher debt also increases expected bankruptcy costs. At low leverage, the marginal tax benefit exceeds the marginal bankruptcy cost, so adding debt creates value. At some point, the marginal bankruptcy cost begins to exceed the marginal tax benefit, and further leverage destroys value. The **optimal capital structure** balances these forces where marginal benefit equals marginal cost. This trade-off is illustrated in Figure 3.

This optimum varies across firms and over time. Firms with stable, predictable cash flows face low bankruptcy risk and can support high leverage. Think of utilities—even in recessions, people need electricity and water. These firms should and do use substantial debt. Conversely, firms with volatile, cyclical cash flows face high distress risk. Think of airlines or luxury retailers, whose revenues plunge in recessions. These firms should use less debt. **Systematic risk is thus a first-order determinant of optimal capital structure**. High-beta firms should use less leverage because their cash flows are most vulnerable precisely when debt service is hardest.

Optimal leverage also varies over the business cycle. In expansions, when cash flows are strong and credit is readily available, firms can safely carry more debt. In recessions, when revenues are weak and credit is tight, bankruptcy risk spikes and the optimal debt level falls. This suggests capital structure should be actively managed, though in practice transaction costs and adverse signaling from equity issues create frictions that prevent continuous rebalancing.

Implementing the trade-off theory is remarkably difficult. While tax shields are relatively easy to estimate (they depend on observable tax rates and debt levels, though future policy changes create uncertainty), bankruptcy costs are devilishly hard to quantify. What's the probability of bankruptcy? This requires complex modeling of cash flow dynamics and their sensitivity to economic shocks. How large are indirect distress costs? These vary by industry and are hard to observe until distress actually occurs. The optimization problem often has no closed-form solution and requires numerical methods with many uncertain inputs. This explains why capital structure remains an active research area, with ongoing debates about how firms actually choose leverage and what additional frictions beyond taxes and bankruptcy might matter.

4 Central Banks, Interest Rates, and the Real Economy

We now have the framework to understand one of the most powerful policy tools in modern economies: central bank control of interest rates. The connection to capital structure might not be immediately obvious, but it's direct and profound. When a central bank adjusts its policy rate, it triggers a chain reaction through the financial system that ultimately affects firms' investment decisions, employment, and economic growth. Let's trace this transmission mechanism carefully.

4.1 The Policy Rate

The **policy rate** is the interest rate a central bank sets and controls directly. It has different names in different jurisdictions—the overnight rate in Canada (set by the Bank of Canada), the federal funds rate in the United States (set by the Federal Reserve), the main refinancing rate in Europe (set by the ECB)—but these all refer to the same concept: the target rate for very short-term lending between banks.

Why focus on interbank lending? Banks need to hold reserves to meet regulatory requirements and manage daily payment flows. At the end of each day, some banks have surplus reserves while others have shortfalls. Rather than holding costly excess reserves or facing penalties for shortfalls, banks lend to each other overnight. The interest rate on these loans is the overnight interbank rate.

The central bank sets a target for this rate and uses **open market operations**—buying and selling government bonds—to hit the target. When the central bank buys bonds, it injects reserves into the banking system. With more reserves available, the price of borrowing them (the interest rate) falls toward the target. When the central bank sells bonds, it drains reserves, pushing the interest rate up. Through these operations, the central bank maintains tight control over the policy rate.

4.2 From Policy Rate to Market Rates: The Transmission Mechanism

The central question is: how does control over one narrow rate—overnight interbank lending—translate into effects throughout the economy? The answer lies in how interest rates are interconnected through arbitrage and opportunity cost.

When the central bank raises the policy rate, say from 4% to 5%, it directly increases the rate banks charge each other for overnight loans. This immediately becomes the **baseline opportunity cost of funds** for banks. A bank can now earn 5% essentially risk-free by lending reserves to another bank. This means the bank will demand at least 5% plus a risk premium to lend to anyone else. Why would a bank lend to a risky borrower at 4% when it could earn 5% risk-free from another bank?

Banks therefore pass their higher opportunity cost on to private borrowers. Mortgage rates rise because banks need to earn more than the interbank rate to justify the risk and illiquidity of mortgage lending. Business loan rates rise for the same reason. The prime rate—banks' benchmark lending rate for their best corporate customers—adjusts upward. These are direct effects of banks' increased opportunity cost of funds.

But the effects extend beyond bank lending rates. Government bond yields also adjust. Investors can now earn higher returns on short-term assets (like money market funds that invest in government securities), so they demand higher yields on longer-term bonds as compensation for locking in funds. This increases r_f, the risk-free rate that appears in CAPM. Corporate bond yields rise as well, since firms must compete with higher government bond yields. This increases r_D, the cost of debt for corporations.

The rise in r_f propagates through CAPM to affect the cost of equity. Recall:

$$r_E = r_f + \beta_E(\mathbb{E}[R_m] - r_f)$$

When r_f increases, r_E increases as well (assuming the equity risk premium stays roughly constant). This happens even though nothing about the firm's systematic risk has changed—we're simply shifting up the baseline rate from which all required returns are measured.

Now both components of WACC have risen. The cost of equity is higher because of the elevated r_f, and the cost of debt is higher because lenders demand more compensation. Therefore:

$$\text{WACC} = \frac{E}{E+D} r_E + \frac{D}{E+D} r_D(1-\tau_c)$$

increases when the central bank raises the policy rate. The firm's cost of capital—the hurdle rate for new investments—has gone up throughout the economy.

4.3 Effects on Investment and Firm Valuation

The increase in WACC has two related but distinct effects. First, it reduces firm valuations mechanically. Since firm value equals the present value of future cash flows discounted at WACC, a higher WACC lowers the present value of any given cash flow stream:

$$V = \sum_{t=1}^{\infty} \frac{CF_t}{\text{WACC}^t}$$

When WACC increases, the denominator grows, so V falls. This is why stock markets often decline when central banks announce rate hikes—the discount rate applied to corporate earnings has increased, mechanically reducing valuations even if cash flows are unchanged.

The second and economically more important effect is on investment decisions. A project is worth undertaking if and only if it has positive NPV:

$$\text{NPV} = \sum_{t=1}^{T} \frac{CF_t}{\text{WACC}^t} - I_0 > 0$$

where I_0 is the initial investment. When WACC rises, the present value of the project's cash flows falls. Projects that were marginally profitable at the old WACC now have negative NPV and won't be undertaken. The **investment space**—the set of positive-NPV projects—has shrunk. Fewer factories get built, less equipment gets purchased, less R&D gets funded.

This is the core mechanism through which monetary policy affects the real economy. By changing the cost of capital, the central bank influences the extensive margin of investment: which projects get funded and which don't. Higher rates mean fewer projects clear the hurdle, reducing aggregate investment. Lower rates mean more projects become viable, stimulating investment.

4.4 The Real Channel: From Investment to Employment to Growth

The reduction in investment creates multiplier effects throughout the economy. When firms invest less in new projects, they need fewer workers. Construction workers, equipment manufacturers, software engineers, project managers—all the labor involved in capital projects—see reduced demand for their services. This is how monetary policy affects **employment**: by changing WACC, the central bank influences investment decisions, which determines hiring.

The full transmission chain unfolds as follows. When the central bank raises rates:

1. Banks' opportunity cost rises; they charge higher rates to all borrowers
2. r_f and r_D increase throughout the economy
3. WACC rises for all firms
4. Fewer projects have positive NPV; investment space shrinks
5. Firms cut back on capital spending
6. Reduced capital spending means less hiring; unemployment rises
7. With less investment and employment, economic growth slows
8. Reduced demand puts downward pressure on inflation

When the central bank cuts rates, the mechanism reverses. Lower policy rates reduce WACC, expand the investment space, increase capital spending, boost employment, and accelerate growth (though potentially fueling inflation if the economy overheats or has limited spare capacity).

This is called the **real channel** of monetary policy because it operates through real investment and employment rather than through purely financial channels. It's the primary mechanism through which central banks manage the business cycle during normal times when inflation is the main concern. By adjusting the policy rate, the central bank can fine-tune the level of investment activity, cooling the economy when inflation is too high and stimulating it when growth is too slow.

Central bank policy is a powerful tool for macroeconomic stabilization. The capital structure framework we've been studying isn't just academic theory—it's the foundation for understanding how monetary policy affects millions of real-world business decisions.

5 (Preview) Hedging and Risk Management with Options

To this point, we've focused primarily on systematic risk—the component of uncertainty that correlates with market-wide movements and can't be diversified away. Systematic risk determines required returns through CAPM and affects optimal capital structure through financial distress costs. But firms face many other sources of risk: commodity price fluctuations, foreign exchange movements, interest rate changes, weather, regulatory shifts. Some of these risks are firm-specific and can be diversified away by shareholders holding broad portfolios. But even when shareholders can diversify, individual firms may want to manage specific exposures that materially affect their operations.

This raises fundamental questions about corporate risk management. When should firms hedge? What instruments should they use? How is hedging different from speculation? And why can't firms simply use stocks and bonds to manage all their risks?

5.1 Hedging Versus Speculation

There are two fundamentally different ways to use financial instruments in relation to risk. **Hedging** means using financial instruments to *reduce* a specific risk exposure—to protect against adverse price movements in something that affects your business. **Speculation** means using financial instruments to *increase* risk exposure—to profit from anticipated price movements. The distinction lies in motivation and effect: hedgers want to eliminate or reduce risk they're already exposed to, while speculators want to take on new risks in pursuit of profit.

Consider an airline. Fuel costs typically represent a large component of operating expenses. When oil prices rise, the airline's costs increase and profitability suffers. The airline doesn't want this exposure—ideally, it would prefer stable, predictable fuel costs so it can focus on running flights efficiently and competing on service quality. Even though airlines are in the business of provided flight services, you can see how they may find it strategically advantageious to manage their exposure to oil price risk. Managing oil price risk is an example of **hedging**.

By contrast, consider a hedge fund manager who believes oil prices will rise based on analysis of supply constraints and geopolitical tensions. The manager might buy oil-related assets to profit from the anticipated price increase. This isn't hedging—the manager has no underlying exposure to oil prices from operations. It's pure **speculation**, taking on risk in pursuit of returns.

The distinction matters for several reasons. Hedging can reduce earnings volatility, lower expected distress costs, and allow management to focus on core competencies rather than commodity price forecasting. Speculation, by contrast, doesn't reduce risk—it adds new sources of uncertainty. While skilled speculation might generate profits, it also exposes the firm to losses in areas outside its expertise. Most corporate finance theory suggests firms should hedge risks related to their operations but avoid speculation in unrelated markets.

5.2 Why Simple Hedges Often Fail

A naive approach to the airline's oil exposure might be to buy shares of oil companies like Exxon or Shell. The logic seems sound: when oil prices rise, oil company stocks typically increase in value, so gains on the equity position could offset higher fuel costs. But this strategy has some limitations.

First, oil company stocks have **systematic risk**. Their returns correlate with the overall stock market, not just with oil prices. During a recession, oil stocks can fall even when oil prices remain high or rise, because the market discounts all risky assets more heavily. The airline would suffer both from potential recession-driven revenue declines *and* from losses on its oil stock hedge. The hedge introduces unwanted beta exposure.

Second, the strategy has **bilateral risk**. If oil prices fall, the airline benefits from lower fuel costs but loses money on the oil stock position. The stock losses might be larger than the operational savings, leaving the airline worse off than if it had done nothing. A true hedge should protect against adverse movements without creating comparable exposure in the opposite direction.

Third, oil stock returns are **imperfectly correlated** with oil prices. Stock prices reflect many factors beyond current oil prices: expectations about future demand, production decisions, geopolitical events, management quality, dividend policy, and so on. The correlation between stock returns and oil price changes is noisy and time-varying, making the hedge unreliable.

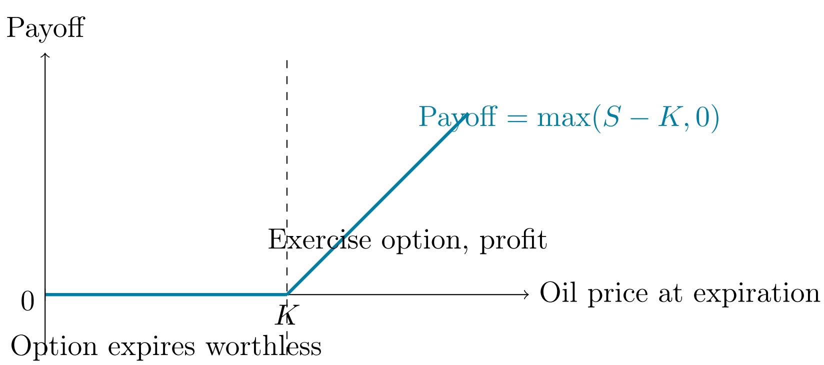
What the airline really wants is an instrument that provides value when oil prices rise (offsetting higher fuel costs) but has limited or zero cost when oil prices fall. It wants **asymmetric payoffs**: benefit from protection against one direction of movement without creating equivalent exposure in the other direction. Stocks and bonds, with their linear payoffs, can't deliver this asymmetry.

5.3 Call Options: The Right Tool for Asymmetric Hedging

A **call option** provides precisely the asymmetry needed. A call option on oil gives the holder the *right* (but not the obligation) to buy oil at a specified **strike price** K at or before a specified **expiration date** T. To acquire this right, the buyer pays an upfront **premium** C to the seller.

At expiration, the option holder faces a simple decision. Let S_T denote the market price of oil at time T. If $S_T > K$, the holder exercises the option: buys oil at the strike price K and can immediately sell at the market price S_T, realizing a gain of $S_T - K$. If $S_T < K$, the holder lets the option expire worthless and simply buys oil at the market price. The option provides no value in this case, but the holder isn't forced to exercise at an unfavorable price. The **payoff** at expiration is therefore:

$$\text{Payoff} = \max(S_T - K, 0)$$



This is the famous 'hockey stick' diagram. When the price is below the strike, the payoff is zero. Once the price exceeds the strike, the payoff rises linearly with the price. The payoff is kinked at the strike price, creating the asymmetry we need.

It's crucial to distinguish between **payoff** and **profit**. The payoff is what you receive at expiration, ignoring the upfront premium. The profit accounts for that premium:

$$\text{Profit} = \max(S_T - K, 0) - C$$

The profit can be negative—if the option expires out of the money, you've lost the premium C. But the maximum loss is capped at the premium paid, while the potential gain is theoretically unlimited. This capped downside with unlimited upside is what makes options useful for hedging.

5.4 How the Airline Uses Options to Hedge

For an airline hedging against rising oil prices, the strategy is to buy call options on oil. Suppose current oil prices are \$80 per barrel and the airline expects to need one million barrels over the next year. The airline could buy call options with a strike price of $K = \$85$, expiring in one year, paying a premium of perhaps $C = \$3$ per barrel.

If oil prices rise above \$85—say to \$95—the airline exercises the options. It has the right to buy at \$85, so it effectively locks in an \$85 price even though the market price is \$95. The \$10 payoff per barrel offsets most of the increased fuel costs (the net benefit is \$7 per barrel after accounting for the \$3 premium). If oil prices stay below \$85, the options expire worthless, costing the airline the \$3 per barrel premium, but fuel costs remain manageable at market prices. The airline has essentially purchased **insurance** against oil price spikes.

Notice the key features. The option payoff depends *only* on oil prices, not on stock market movements, so there's no unwanted systematic risk exposure. The downside is limited to the premium paid—the airline knows upfront the maximum cost of the hedge. The protection is precisely targeted to the specific risk the airline faces: rising input costs. And the airline retains the benefit if oil prices fall (though offset by the premium cost).

5.5 The Challenge of Pricing Options

Understanding what options do is one thing; determining what they're worth is considerably harder. At first glance, pricing seems straightforward. An option is a claim to future cash flows, so its value should equal the present value of expected payoffs:

$$C = \text{PV}[\mathbb{E}[\max(S_T - K, 0)]]$$

But this formula conceals enormous complexity. The payoff depends on the future price S_T, which is uncertain. To compute the expected value, we need the entire probability distribution of future prices. What discount rate do we use? The option's payoff is nonlinear in the underlying price, so it's not obvious what systematic risk the option has or what beta to assign. How do we estimate the probability distribution of future prices?

The breakthrough in derivatives pricing came from recognizing that we don't need to estimate probabilities or expected returns directly. Instead, we can use **no-arbitrage arguments** combined with **replicating portfolios**. The key insight is that if two portfolios always have identical payoffs in every possible state of the world, they must have the same price today. If they didn't, investors could engage in arbitrage: buy the cheap portfolio, sell the expensive one, and lock in a risk-free profit.

It turns out that an option's payoff can be replicated using a dynamic trading strategy in the underlying asset and a risk-free bond. By continuously adjusting the portfolio as prices change, we can create a synthetic option that has exactly the same payoff as the actual option in every possible future state. Since we know the prices of the underlying asset and bonds, we can infer what the option must be worth without ever estimating expected returns or forming beliefs about future price distributions. This is the foundation of the binomial tree model and the Black-Scholes formula, which we'll develop in the next lecture.

This approach—pricing by replication and no-arbitrage rather than by discounting expected payoffs—is one of the most important innovations in modern finance. It allows us to price complex derivatives without taking a stand on risk preferences or expected returns, relying only on the absence of arbitrage opportunities. Next week, we'll formalize these ideas through put-call parity, the binomial model, and ultimately the Black-Scholes formula, giving you the tools to value the derivatives that firms use for risk management and that appear throughout modern financial markets.

6 Conclusion

This lecture has woven together several fundamental strands of corporate finance theory, showing how they connect to form a coherent picture of how firms should finance themselves and manage risk.

We began with the irrelevance theorem, which establishes that in a frictionless world, capital structure is irrelevant to firm value. This isn't a claim about the real world—it's a benchmark that tells us where to look for explanations of why capital structure matters in practice. Any real-world theory of optimal leverage must identify specific market frictions that create value-relevant deviations from this benchmark.

Adding corporate taxes provides one such friction. The tax deductibility of interest creates an interest tax shield that makes debt financing effectively cheaper and increases firm value. But the tax shield does more than just boost value—it also affects risk. The $(1 - \tau_c)$ term in the equity beta formula shows how taxes dampen the leverage effect on systematic risk. This has implications reaching beyond individual firms: corporate tax policy influences the stability of equity markets economy-wide, with higher tax rates acting as automatic stabilizers that reduce systematic volatility. Bankruptcy costs provide the counterweight to tax benefits. While the tax shield encourages leverage, the expected costs of financial distress—both direct legal costs and indirect costs like lost customers, suppliers, and employees—discourage excessive debt. The trade-off theory of optimal capital structure balances these forces. The optimal debt level varies across firms based on their systematic risk exposure (high-beta firms should use less debt) and over time with macroeconomic conditions (firms should reduce leverage as recession risk rises).

We then connected these firm-level decisions to monetary policy. Central banks control a single interest rate—the policy rate for overnight interbank lending. But through interconnected financial markets, changes in the policy rate propagate to all other interest rates: risk-free rates, costs of debt, costs of equity, and ultimately WACC. When the central bank raises rates, WACC increases, shrinking the set of positive-NPV investments and reducing capital spending, employment, and growth. This is the real channel of monetary policy, operating directly through the corporate finance framework we've been studying.

Finally, we introduced options as tools for managing risks that can't be effectively hedged with stocks and bonds alone. The asymmetric payoffs of options allow firms to protect against specific adverse movements without creating equivalent exposure in the opposite direction. This makes derivatives essential for corporate risk management. Pricing these instruments requires moving beyond simple discounting of expected payoffs to techniques based on replication and no-arbitrage, which we'll develop in depth next week.

The common thread throughout is systematic risk. It determines required returns through CAPM. It affects optimal capital structure through bankruptcy risk and is either amplified or dampened by leverage depending on tax policy. It connects central bank policy to real investment decisions through the cost of capital. Corporate finance isn't just about individual firms making isolated financing decisions—it's about how the economy as a whole allocates and prices systematic risk, and how policy choices reshape that allocation with consequences that reach from boardrooms to labor markets to household wealth.