

# NOTE 4: RISK AND RETURN

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# AGENDA

- 1 PRELIMINARIES
  - Introduction to valuing unlevered projects
- 2 QUANTIFYING AND PRICING RISKS
  - Various notions of risk
  - Pricing risk
- 3 THE CAPM
  - Theory and intuition
  - CAPM implementation
- 4 CONCLUSION

# DISCOUNTED CASH FLOW METHOD

- Forecast Cash Flows
- Estimate the rate at which to discount future cash flows
- Calculate Net Present Value: Discounted value of all future Cash Flows

# VALUING UNLEVERED PROJECTS WITH RISKY CASH FLOWS

- For now, assume our firm is all equity financed
- To implement the present value formula when cash flows are uncertain we must deal with:
  - ① Future cash flows are uncertain: the numerator is a *random variable*
  - ② The opportunity cost of capital is not obvious - must find investments with comparable risk. Need to quantify and price risk

# FORECASTING FUTURE CASH FLOWS

- Forecast means Expected Value (in the statistics sense)
- Can estimate using comparables from similar firms in the industry
- Can project cash flows using current performance numbers
- Must consider only incremental cash flows

# USING PRO-FORMA PROJECTIONS

- Cash Flow Estimate:

Earnings before Interest and Tax  $\times (1 - \text{Tax Rate})$

+ Depreciation

- Capital Expenditures

- Change in Net Working Capital

- Terminal Value = Cash Flow in last period  $\times (1 + \text{growth rate}) / (\text{discount rate} - \text{growth rate})$

- $\Rightarrow TV_T = \frac{CF_T(1+g)}{r-g}$

# WHAT IS RISK? ...1

- “*Risk is the uncertainty of future outcomes*” – Finance text books
- “*Risk means more things can happen than will happen*” – Elroy Dimson, a famous finance professor
- “*My momma always said, ‘Life is like a box of chocolates. You never know what you’ll get next.’*” – Forrest Gump

# WHAT IS RISK? ...2

- Bad outcomes
- Probability of Failure
- Volatility
- Bad outcome when things are bad everywhere



# HOW DOES THE MARKET PRICE RISK?

- Probability of bad outcome is priced by calculating expected values (numerator)
- How to price volatility?
- If we know how the market compensates for taking on risk, we can factor this into the discount rate (denominator)
  - To develop the relationship between risk and return, let us understand the idea of diversification with an example
  - Consider the following two assets: An auto stock and gold with returns in possible states of the world tomorrow as follows:

State	Probability	Auto Stock	Gold
Recession	0.33	-8%	20%
Normal	0.33	5%	3%
Boom	0.33	18%	-20%

## Statistics

Expected return	<b>5.0%</b>	<b>1.0%</b>
Variance	0.0113	0.0269
Standard deviation	<b>10.61%</b>	<b>16.39%</b>

- Question: Would you care to hold gold at all? Why or why not?

# MEASURING PORTFOLIO RISK

- The underlying assumption is that investors like expected returns but dislike risk.
  - One useful measure of risk is the variance of a diversified portfolio.
- In this example, we consider the case of two assets with portfolio weights summing to one:

$$\begin{aligned} \text{Var}[wr_1 + (1 - w)r_2] &= w^2 \text{Var}(r_1) + (1 - w)^2 \text{Var}(r_2) \\ &\quad + 2w(1 - w) \text{Cov}(r_1, r_2) \end{aligned}$$

- Can we use this formula to answer our previous question?

# DIVERSIFICATION EXAMPLE ... CONTINUED...

State	Probability	Auto Stock	Gold	Portfolio
Recession	0.33	-8%	20%	-1%
Normal	0.33	5%	3%	5%
Boom	0.33	18%	-20%	9%

## Statistics

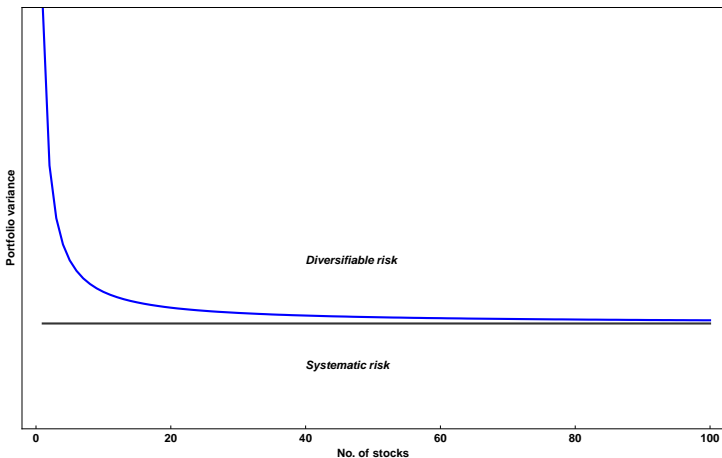
Expected return	5.0%	1.0%	4.0%
Variance	0.0113	0.0269	0.0015
Standard deviation	10.61%	16.39%	3.89%
Covariance			-0.0173
Correlation			-0.996

- Drastic risk reduction without too much sacrifice in expected return!
- Effect of diversification!
- What's the intuition?
- What happens with  $N > 2$  risky assets in a portfolio?

# DIVERSIFICATION BEYOND TWO ASSETS

- In general, as we keep adding assets to a portfolio, risk must reduce, as we saw in the above example...
  - Question: Will the risk ever go to zero? i.e., is there a combination of the risky assets that is completely risk-free?
  - Answer: Generally, **no**
- Start with (n asset) portfolio variance: 
$$\sigma_p^2 = \sum_{i=1}^n w_i^2 \sigma_i^2 + \sum_{i=1}^n \sum_{\substack{j=1 \\ i \neq j}}^n w_i w_j \sigma_{i,j}$$
  - Assume all assets have a variance  $v$ , and each pair of assets a covariance  $c$
  - This means  $\sigma_p^2 = n \frac{1}{n^2} v + n(n-1) \frac{1}{n^2} c = \frac{1}{n} v + \frac{n-1}{n} c$
  - As  $n \rightarrow \infty$ ,  $\frac{1}{n} \rightarrow 0$ , and  $\frac{n-1}{n} \rightarrow 1$ , which implies  $\sigma_p^2 \rightarrow c$
- Conclusion 1: For a well-diversified portfolio, covariances matter, not so much the variances
- Conclusion 2: If  $c$  is not zero, we cannot diversify away all risk: leads to the idea of diversifiable (idiosyncratic) vs. undiversifiable (systematic or market) risk

# DIVERSIFICATION IN WELL-DIVERSIFIED PORTFOLIOS



# MARKET AND UNIQUE RISK

- Another way to think about this is:

$$\text{Total Risk} = \text{Market Risk} + \text{Unique Risk}$$

- In a large and well diversified portfolio unique risks will tend to even out but market risks will not go away
  - Unique risks are idiosyncratic to the firm (i.e., the success of an R&D project, labor strike, etc.).
  - Market risks tend to move all stocks together (i.e., changes to GDP growth, interest rates, exchange rates, oil prices, etc.)

# COMPENSATION FOR RISK

- If investors hold well diversified portfolios we would *not* expect them to be compensated for bearing unique risks
  - Why?
- However, we *would* expect them to be compensated for bearing market risk as it cannot be diversified away
- **Asset pricing models** attempt to answer the following two questions
  - 1 What are the relevant measures of risk affecting expected returns?
  - 2 What is the relationship between these measures and expected returns?
- This will allow us to determine the opportunity cost of capital

# CONCEPT SUMMARY

- Diversification: Sharing risks
  - If risk is not systematic we can spread it
  - If risk is systematic, we cannot
- Market demands a premium for bearing risks that cannot be diversified
- To achieve higher expected excess returns, an investor must bear greater systematic (market) risk
- The historical returns on different asset classes are consistent with this statement



# PRICING SYSTEMATIC RISKS

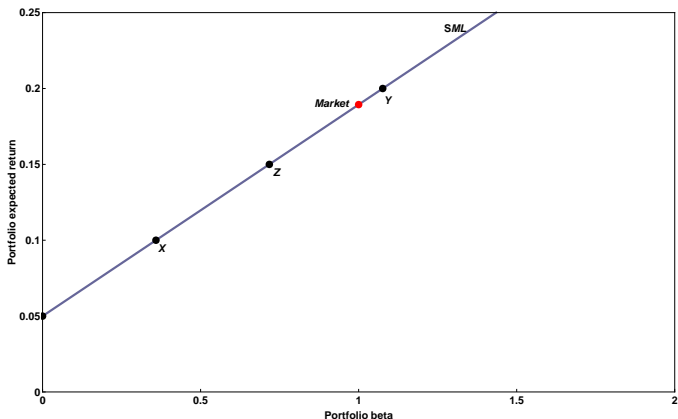
- The Capital Asset Pricing Model: CAPM
- Expected return = Risk free rate + Beta × Market risk premium
- $E(r_i) = r_f + \beta [E(r_m) - r_f]$
- Beta: Measure of Systematic Risk
- Market Risk Premium = Expected Return on Market Portfolio - Risk Free Rate
- We can use the CAPM to determine the opportunity cost of capital when cash flows are uncertain
- Warning: Computing expected cash flows does not fully incorporate risk - so, you should not discount using the risk-free rate

# WHAT THE CAPM IS SAYING (IN ENGLISH)

- Covariance (with the market portfolio), not variance, is the appropriate measure of risk
  - The marginal contribution of an asset to a portfolio's risk is entirely due to its covariance with the market
- High beta assets have high expected returns
  - High beta assets produce high returns when the market return is high, i.e., when the marginal value of an extra \$1 is low. Low beta assets have the opposite property
  - When you really need the money (in bad states of the world), high beta assets fare poorly. So, to induce investors to hold these assets, they have to offer high expected returns
- Beta alone determines expected returns
  - Once beta is taken into account, nothing else matters for expected returns
  - This is the implication that has been incompatible with historical data
- Diversifiable risk is not priced, i.e., if an investor is dumb enough not to diversify, he will not be compensated
  - Remember the formula: Return on Idiocy (ROI) = 0

# THE SECURITY MARKET LINE

- The Security Market Line (SML) is a graph of the CAPM



- In equilibrium, all assets should lie on the SML

# WHY CAPM ?

- Who is valuing the cash flows?
  - Diversified Investor
- What is his/her opportunity cost? What else could he/she do with his money?
  - He/She could invest in a diversified portfolio that is equivalent in terms of risk, i.e., has the same beta
  - Since  $\beta$  is the only relevant measure of risk in determining the opportunity cost of capital, we only need to price a **comparable** portfolio that has the same  $\beta$  to value the project
- **Big question:** If **all** assets lie on the SML, i.e., satisfy the CAPM, what is the point of investing in corporations?

# ESTIMATING CAPM $\beta$ s

- We can estimate  $\beta$  from the regression of the excess return of a stock on the left-hand-side and the return on a proxy for the market portfolio (i.e., S&P 500, NIFTY etc.) on the right-hand-side
- Monthly data is often used, but weekly data can be used for heavily traded stocks (large firms in particular)
- There are several techniques for shrinking the estimates of  $\beta$  to account for estimation error (Why?)

# ESTIMATING EXPECTED RETURNS

Why not use historical average returns to estimate expected returns?

- Estimating Means
- Estimation error
- Data requirements

# CAPM INPUTS

- In theory, the market portfolio should include real estate, human capital, and other hard-to-value assets
  - Usually, we only consider market proxies, such as the S&P 500, NASDAQ, NIFTY stocks, etc.
- Typically the short-term T-bill return proxies for the risk-free rate.
  - An often used (and reasonable) practice is to choose a Treasury with a duration roughly matching the duration of the project cash flows

# CAPM INPUTS - CONTINUED

- Estimating the market risk premium is very difficult!
- The historical average excess return is often used (roughly 7-8% in the US) but:
  - This is problematic if expected excess returns are not stable (predictable) over time.
  - If expected excess returns have fallen over time then the average ex post excess returns will overestimate the ex ante risk premium.
  - Survivorship bias



# RISK AND RETURN IN CORPORATE FINANCE

- CAPM is a very popular choice
- Beta makes logical sense
- We often do not bother if the CAPM is “right”
- So, far we have only dealt with all-equity firms...we need to think about what happens if we have debt in a company!