Capital Budgeting Applications

We now cover a range of topics in the application of NPV.

The relatively simple concept of NPV—divide expected cash flows by one plus the cost of capital, and sum up—can quickly become very, very difficult in applications in the real world.

Statistics

Q1: What is the value of your degree if you will likely earn $300,000 per year for 40 years because of your degree and the interest rate is 5% per annum?

Q2: You expect to earn $300,000/year. Holding money for a drug-dealer would earn you an extra $100,000 per year. You are unlikely to be caught. Morals aside, should you do it?

The problem here is that we tend to intuitively think of typical or most likely outcomes, not of average outcomes. Most often, the "unusual" is bad news, not good news.

Cost of Capital Blending

Q3: A Firm has a cost of capital of 10%. It can find a project that offers a rate of return of 20%. Does this add value?

Q4: Can firms create value by reducing risk through diversification?

Merger Profitability #1

ACQ conglomerate is thinking about taking over TGT corporation. ACQ and TGT both will last only one more year. ACQ expects cash flows of $500 million. TGT corporation expects cash flows of $300 million. ACQ has a beta of +1.5. TGT has a beta of +3.0. The equity premium is 2% per year, the risk-free rate is 2% per year.

Please give everyone a chance to think about this problem's individual questions, as we go along. Reflect on the questions. Please do not answer immediately.

Q5: What is the stock market price of the two corporations?

Q6: ACQ's executives evaluate potential takeover targets by using their *own* cost of capital, not the target's cost of capital. They do however recognize the correct expected cash flows. What do they think the value of TGT is?

Q7: ACQ executives make a takeover offer for $280, which is accepted. What is the value gain/loss to the two shareholders?

Q8: ACQ executives finance this takeover offer by issuing a new $280 million from new shareholders. How much expected rate of return will they have to promise to the new shareholders?

Q9: What share of the overall new firm needs to be given to TGT shareholders to be the equivalent (raising of) $280 million?

Q10: What share of the firm do the ACQ shareholders own?

Q11: Given the old shareholders remaining percentage of the firm, what are their shares worth?

Q12: Upon announcement of the deal, what happens to the shares of ACQ corporation? What happens to the shares of TGT corporation?

This is an example in which an acquiring firm loses value because it takes a bad project. We could also construct examples in which an acquirer loses value because it passes up a good project.
For example, if you can invest in some T-bond equivalents at a 5% rate if the market T-bond rate is only 3%, this creates value—but if you use your firm-wide 10% cost of capital that applies to risky projects, then you would incorrectly pass up on this great opportunity.

Q13: If a firm raises capital for a project that is to-be-built over the next 5 years, and invests the unused cash in treasuries, how does the fact that the treasury bill offer a lower expected rate of return hurt the company?

Maybe tell students to check weight calculations, etc., with an example of a fair purchase first. (some students were wondering whether weight should be computed from future cash flows or current cash flows.)

Project Specific Costs of Capital

Q14: As a manager, should you use the cost of capital unique to each project and to each project component; or should you use the overall corporate cost of capital, which you last raised capital with, or what you could be raising capital soon (which, in the example, would be ?)

Q15: Should all Ford projects have the same hurdle rate?

Q16: What about the cost of capital of the manager's desk vs. the cost of capital of the secretary vs. ...

Important: Watch the difference between average and marginal cost of capital—even later, when we will compute the WACC of a firm.

Merger Profitability #2

Q17: A firm is 60% debt and 40% equity. Its equity has a beta of 1.5. The market risk premium is known to be 5%, the risk-free rate is 4%. The firm has just discovered a project that is similar to its "average project" or "typical project" in all sorts of characteristics. What is an appropriate discount factor for this *project*?

First, do it with a $\beta = 1.5$. This comes to a cost of capital of

$$\mathcal{E}(R) = 4\% + 1.5 \cdot 5\% = 11.5\%.$$

Ahem—this was all wrong.

Let's work out the asset beta:

$$\beta_{\mathsf{FM}} = w_{\mathsf{EQ}} \cdot \beta_{\mathsf{EQ}} + w_{\mathsf{DT}} \cdot \beta_{\mathsf{DT}}$$

Assume that β_{DT} is close to zero. Then

$$\beta_{\mathsf{FM}} = 60\% \cdot 1.5 = 0.9$$

This means that the project should have a hurdle rate of

$$\mathcal{E}(R) = 4\% + 0.9 \cdot 5\% = 8.5\%.$$

Q18: (continued) This firm has a marketcap of $100 million. This new project costs $20 million. If the new project offers an expected rate of return of 6% (10%, 15%) and the firm takes it, how does the firm's existing shareholder value change?

With $20 million in cost, a 6% return is $21.2 million.

With $20 million in cost, a 10% return is $22.0 million.

With $20 million in cost, a 15% return is $23.0 million.

The appropriate hurdle rate being 8.5%, the project has an NPV of $21.2/(1+8.5%)= $19.54. The project cost $20 million. We have just destroyed about $500,000. So, the value of the old equity would decline by this amount.

Q19: Alternatively, the firm can invest $20 million money in a relatively risk-free piece of land. If the new land project offers an expected return of 6% (10%, 15%), how does the firm's value change?

The project would earn 2% (6%, 13%) above its cost of capital. At $20 mill upfront cost, this creates $400,000 in value.

Q20: Being on this alternative land would increase the efficiency of the firm's old operations by 35%. How would you value the project now?

As before, but gross up the operations by 35%. Not clear what this means though to expected return. If there are fixed costs of selling or limits to sales capacity, it may not even matter at all!

Q21: How does a higher firm's cash balance influence its cost-of-capital?

It reduces its beta, so it lowers the average cost of capital.

Project Interactions (Externalities) 12-4

An access road or computer system that benefits all divisions. I cannot (and do not want to) prevent you from using the road after it has been built.

Cost: \$30 million

	Division Size	Profits	Bonus	Division Marginal Benefit
A	\$30 million	\$10 million	10%	
B	\$300 million	\$100 million	2%	
C	\$3 million	\$0.3 million	50%	
D	\$30 million	\$2 million	10%	
E	\$300 million	\$1 million	2%	
F	\$3 million	\$2 million	50%	

Q22: As division manager, how is your annual bonus determined?

I am the overall firm manager. You report to me. I do not know you marginal benefit. I am naive—I take your report to me at face value. I make two decisions:

- Whether to purchase the computer or not. If I do, it will cost me \$20 million.
- If we buy the computer, then I will allocate the cost proportionally to divisions that report to me how much they gain. For example, if A reports \$30 million and B reports \$70 million in gain, then I will

allocate $\$30/\$70 + \$30 = 30\%$ of the $30 million (i.e., $9 million) to A and $21 million to B.

- Your salary is calculated based on your bonus percentage on your profits. For example, without the computer, A's manager is expected to take home $1 million, B's manager is expected to take home $2 million.
- Next year, when I retire, the most profitable division manager will succeed me.

will determine your contribution to the cost of building the road based on how much you are telling me it is worth to you. The more profitability you have, the more money you are getting from me.

Q23: Each team: please submit to me how much you want to pay for the road.

Q24: Does it matter to the CEO of the corporation who is charged with the building of the road, if all profitable roads (NPV projects) are taken?

Q25: As the overall CEO, who should you charge?

Assume that A wants to build the road, and then tell the CEO to charge B $5 million and C $12 million.

Q26: As manager of B, what will you claim after A has built the road?

Q27: As manager of A, what will you claim after you have built the road?

Q28: Are problems solved if you discussions occur ex-ante?

Q29: If you ask B before the road decision is made, what will they say?

Q30: Who should headquarters trust?

(Tragedy of the Commons—no one has ever washed a rental car.)

Project Externalities

IMPORTANT: Project externalities : Allocate all costs and benefits to every project at the capital budgeting (project decision) stage.

Best Rule (12-4A): Choose best combination of *all* projects. Realistically, not feasible to compute, or to execute.

Project Pairs (12-4B):

- If there are zero externalities, then project NPVs can be added.
- Common causes of **negative** externalities: Pollution. Limited Attention Span (Forgetting!). Cannibalization (opportunity costs).
- Common causes of **positive** externalities: Overhead sharing. Specialization. Product needs.

  Positive externalities are the reason why firms exist.

(Advice: read the chapter again. Start with the homework. There will be a lot of homework soon. Also, read the PepsiCo 2006 annual report.)

The Marginal (Incremental) Perspective

Example

A company has office staff which costs $300,000/year. It rents 40,000 square feet of space at a price of $800,000/year, but 10,000 square feet remains unused. Our company produces revenues of $1,400,000/year. The company will exist forever. The discount rate is 10%/year.

NEWS: The company is contemplating expansion. A new division, using the remaining 10,000 square feet, would cost $500,000 to develop, and bring in $210,000 per year forever.

Q31: What is the cost per square-foot of rent per year?

Q32: What should be the implicit rent of the new division

Q33: Taking the rent into account, what is the profit of the new division?

Q34: At the noted one-time cost of $500,000, should the firm expand?

Q35: What will the existing division chair argue?

Q36: How do most corporations allocate overhead?

Marginal vs. Total Perspective

Should you invest in an additional project? The answer is yes only if it increases the value of your operations.

$$\text{Test} \;=\; \mathsf{PV} \text{ operation with project} \;-\; \mathsf{PV} \text{ operation without project}$$

If Test$>$0 take on the project. If Test$<$0 reject the project. This is equivalent to adding/subtracting externalities where appropriate.
If one project is already given, you can think of adding a project "on the margin." For adding projects, always think of marginal contributions, not average contributions.

Incremental + Economies of Scale

12-4.C.?

Important: Think in terms of marginal cost and marginal gain.

Book has an example of economies of scale. Read.

Book has an example of overhead allocation. Read.

Sunk Costs

12-4.C.?

Do not include sunk costs. A sunk cost is any cost the firm must incur whether or not the project is undertaken.

Q37: Joe's Burgers has invested $20,000 to obtain the necessary permits to open. Joe expects that another $5,000 in equipment is needed to finish remodeling. Once his hamburger joint opens, it will produce $400 in profits per year forever. The appropriate cost of capital for Joe's is 10%. Should Joe remodel?

Important: Do not throw good money after bad.

Important: Ignore stuff that has to be incurred no matter what.

Over time, almost everything becomes a sunk cost.

Tougher NPV Questions: Strategic Options

Does this all look too easy?

- A business produces 100,000 gadgets.
- A gadget costs $1 each to produce.
- The market price of gadgets is $1.80 each.
  Demand is perfectly elastic.
- To produce another 100,000 gadgets requires running the machine at night. These extra 100,000 gadgets however cost not $1 but $2 to produce.
- You own the factory for exactly two years.
- The gadget price process is:
  - With 10% probability, the output price doubles after exactly one year.
  - With 10% probability, the output price halves after exactly one year.
  - With 80% probability, the output price stays the same.

  So, the expected price is $1.89.
- Shutting down the plant, doubling production, or reopening it costs nothing.
- The cost of capital is a constant 5% per year.

Q38: What is the value of this plant? How do you go about solving this?

Q39: Repeat previous example, but for 5 years.

Q40: As before, but assume that switching state costs $20,000. The cost of capital is a constant 5% per year. What is the value of this plant? How do you go about solving this?

This becomes even more difficult if the cost of capital is not 5%, but itself depends on the tree. In this case, if the underlying commodity is traded—e.g., as is oil for drilling exploration—then you can use complex contingent claims option-pricing techniques.

Q41: Do you like variability?

Strategic/Real Options

Most projects have many embedded strategic options:

- The ability to leverage a product into future markets?
- The ability to find product spinoffs?
- The ability to learn about (how to do) future products?
- The ability to stop the project if conditions are bad.
- The ability to delay the project if conditions are bad.
- The ability to mothball the project if conditions are bad and restart the project if conditions improve.
- The ability to accelerate the project if conditions are good.
- The ability to expand the project if conditions are good.

Q42: What is the value of unbuilt land?

Q43: What is the value of R&D?

Important: Real options have more value when there is more variability.

See the webchapter for more sophisticated solution techniques.

Strategic Options, Real-World

- 52% of managers do sensitivity analysis (not scenario analysis, but similar).
- 27% work with real options.
- 14% do simulations.

Human Biases

Q44: Are you overconfident?

Please do not prepare. Please do not game your answers—tell us honestly.

- How old is your instructor?

  0-100 is too big. (44 years, 2 months, 1 day) to (44 years, 2 months, 2 days) is too narrow. This is not a question about the actual age, as it is in your confidence about the age. If you have no clue, or if you know the answer to the year, you should be doing equally well.

1. When was Beethoven born (baptized)?
2. When did Andy Warhol die?
3. How far can swarms of desert locusts migrate?

4. How many member states does the UN have?
5. Empty Weight of 747-400 in lbs (or kg)?
6. What is Michael Jordan's highest number of points in one regular season basketball game.
7. In what year was Brown U founded?
8. What was Brown U's acceptance rate for the class of 2008?
9. How many people lived in Providence on April 2000, according to the U.S. census?
10. What was AT&T's operating income in 2002?

More Human Biases

Q45: Are you overconfident?

Q46: Are you more likely to drive 1 hour to save 20% on a $1,000 Macbook, or 1% on a high-end VW Passat?

Q47: As you are about to drive off to the Celtic's game, you realize that you have just lost your $100 ticket. Would you call the Box Office to purchase another one?

Q48: As you walk back to your car, you see that you got a parking ticket. Actually, the car was parked right, and you could prove it in court. But, you parked incorrectly the entire last week, and got no parking ticket, so you saved 5 tickets that you really deserved. How does this change your inclination of going to court?

Agency Biases

Conceptual Framework: You are the selfless representative of the owners—the shareholders. You know you will disappear from the scene tomorrow. In fact, you may be the 100% owner today, and design the firm in order, either to go visit Mars for the next 20 years, or to sell off all your shares tonite.

- **Q49:** How do you think managers and employees might act not in your interest? Would you worry about it?

- **Q50:** In what kind of projects/firms are these problems most rampant?

- .

Q51: What can you do to alleviate these concerns?

Conclusion

- See the NPV checklist at the end of the chapter.

NPV is as much a way of thinking about all sorts of business problems as it is a formula. The formula is easy; the application is hard.

Homework Assignment

1. Reread Chapter 12.
2. Read Chapter 13.
3. Hand in all Chapter 12 end-of-chapter problems, due in 7 days.
4. Additional Homework: Read the 2006 Annual Report for PepsiCo for the next class. You do not need to really understand it, but pay special attention to the financials.