CHAPTER 8: STRATEGY AND ANALYSIS USING NPV

Assigned problems are 1, 19, and 20. Skip textbook section 8.3.

I. Introduction

Capital or financial Markets are generally assumed to be efficient and competitive. It should be difficult to consistently earn *above normal* returns in the stock and bond markets. Stocks and bonds are considered to be zero NPV investments.

However, the market for real goods and services is less perfect. It may be possible to exploit business investment opportunities that earn above normal returns. This means that positive Net Present Value opportunities may exist.

Positive NPV ≡ PV of outputs > PV of inputs

Positive NPV ≡ economic return > economic cost

Some causes of +NPV:

(1) Introducing new products that satisfy some unmet demand

(2) Developing a core technology

(3) Creating barriers to entering the industry

(4) Introduce innovative variations on existing products

(5) Product differentiation or brand identification

(6) Using organizational innovation

There is a strong correlation between the stock market and capital budgeting, as well as merger/acquisition activities:

- Unexpected increases in planned capital expenditures are associated with an increase in stock price.
- Mergers that *create* value (+NPV) will increase stock prices; e.g., the Exxon and Mobil merger.
- Mergers that *do not* create value will decrease stock prices; e.g., the AOL and Time Warner merger.

II. Real Options and Decision Trees

In order to pursue a project, \$500 must be spent now (t=0) to explore the project's feasibility. Next year (t=1), the option or decision to continue or abandon the project will be exercised. The cost of capital is r=15% per year.

If the project is accepted next year, it will cost an additional \$1500 at t=1 and will produce cash flows in years 2 through 6 (t=2 through t=6 years).

Based on current forecasts, there is a 70% and 30% probability that cash flows CF_2 through CF_6 will be \$1000 and \$400 per year, respectively. At t=1, we will know whether the final outcome is \$1000 or \$400 per year.

As will be shown, the traditional or static NPV method from Chapters 6 and 7 is *incomplete* and fails to address the *managerial options* that are actually available.

Traditional or Static NPV method:

Calculate the *expected* cash flows CF_2 through CF_6.

E(CF) = (0.70)(1000) + (0.30)(400) = \$820 per year.

A time line of the expected cash flows is shown below. The project costs \$500 now for the feasibility study and another \$1500 next year if continued.

t=0	t=1	t=2	t=3	t=4	t=5	t=6
CF_0 = -500	CF_1 = -1500	CF_2 = 820	CF_3 = 820	CF_4 = 820	CF_5 = 820	CF_5 = 820

We can calculate the *expected* NPV next year at t=1. Note that the CF_2 through CF_6 cash flows are treated as an n=5 year annuity from the perspective of t=1.

$$NPV_1 = -1500 + 820\left[\frac{1}{0.15} - \frac{1}{0.15(1+0.15)^5}\right]$$

NPV_1 = -1500 + (820)(3.352155) = **\$1248.767**

Now calculate today's (t=0) NPV_0, taking into account the current \$500 feasibility study and also discounting the NPV_1 back to today at r=15%.

$NPV_0 = -500 + NPV_1/(1+r)$ = -500 + 1248.767/(1+0.15) = **\$585.884**

Based on this NPV_0, the project would be accepted. However, this type of NPV calculation is actually *incomplete*. Note that we have only estimated a series of expected cash flows, and have completely ignored the management's *option* to continue or abandon at t=1.

Dynamic NPV method (includes managerial options):

If the t=0 feasibility study of $500 is approved, then one year from now at t=1, we will actually know whether or not this project is a success or failure. All we really know now (t=0) are the probabilities of success (p=0.7) or failure (p=0.3) that will produce cash flows CF_2 through CF_6 of $1000 or $400 per year, respectively.

First calculate the NPV at t=1 if the project is known to be *successful*:

Success NPV_1: $NPV_1 = -1500 + 1000\left[\frac{1}{0.15} - \frac{1}{0.15(1+0.15)^5}\right]$

Success NPV_1 = -1500 + (1000)(3.352155) = **$1852.155**.

Next calculate the NPV at t=1 if the project is known to be a *failure*:

Failure NPV_1: $NPV_1 = -1500 + 400\left[\frac{1}{0.15} - \frac{1}{0.15(1+0.15)^5}\right]$

Failure NPV_1 = -1500 + (400)(3.352155) = **-$159.138**.

Will the firm actually accept this project at t=1 if it is known to be a failure? The answer is NO, the project will just be *cancelled* and the actual NPV_1 = $0.

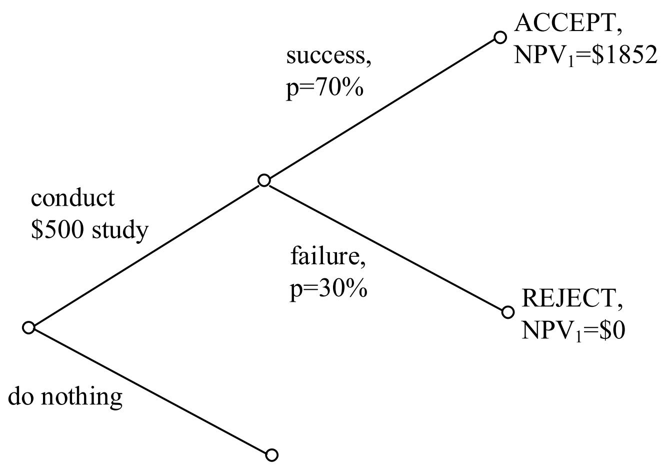
The *static* NPV computed above ignored the fact that managers will just cancel the project next year if the future cash flows are known to be only $400 per year. The current *dynamic* NPV_0, encompassing the option to abandon, is now found.

Dynamic NPV_0 = -500 + (0.7)[success NPV_1/(1+r)] + (0.3)[failure NPV_1/(1+r)]

NPV_0 = -500 + (0.7)[1852/(1+0.15)] + (0.3)[0] = **$627.399**

Now compare this dynamic NPV to the static NPV found earlier. The difference of 627.399 – 585.884 = **$41.52** represents the value today of the option to abandon.

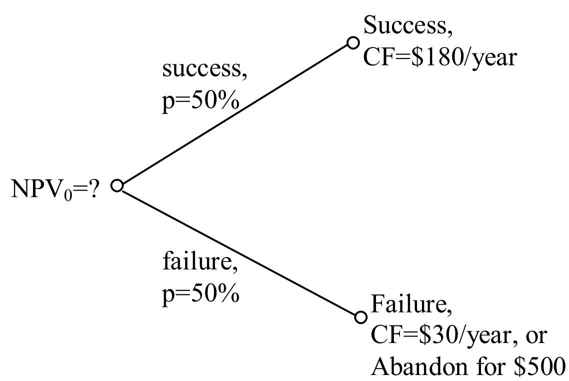
The static NPV neglects the value of the option to abandon. The option to abandon has value since there is a 30% probability that product demand will turn out to be lower than expected. The following *decision tree* can illustrate this type of project.



III. Second Example

At t=0, a project's probability of success or failure are each 50%. At t=1, we will actually know whether the project is a success or failure. The project costs $1100 today and the cost of capital is r=10% per year.

If a *success* or *failure*, then the project generates perpetual cash flows of $180 or $30 per year forever, respectively. The first cash flow of the perpetuity occurs at t=1. However, if *abandoned* at t=1, the project's assets can be sold for a salvage value of $500, just when the first (and last) cash flow of $30 is received



NPV_0 (if success) = -1100 + 180/0.1 = -1100 + 1800 = **$700**

NPV_0 (if failure): this issue must be further addressed in detail. Either the project can be continued at t=1 or it can be abandoned and the asset sold for $500.

First, calculate the NPV_0 if as though the project is *continued* in operation as a failure with the $30 annual cash flows:

Failure NPV_0 = -1100 + 30/0.1 = -1100 + 300 = **-$800**

Now investigate *abandoning* the project at t=1 if we realize it is a failure. At t=1 one (the only project cash flow since the project is then cancelled) cash flow of $30 is received and then the assets are sold for $500.[1] This abandon upon failure NPV_0 is thus:

NPV_0 = -1100 + 30/(1+0.1) + 500/(1+0.1) = -1100 + 481.18 = **-$618.18.**

Now calculate the total Dynamic NPV_0 of the project.

Dynamic NPV_0 = (0.5)[success NPV_0] + (0.5)[failure NPV_0]

Dynamic NPV_0 = (0.5)[700] + (0.5)[-618.18] = **$40.91**.

The project is should be accepted due to the +NPV.

***Static* NPV of same project (ignoring the managerial options):**

This approach is now obviously incomplete, based on this project's characteristics. However, this static approach uses the *expected* annual cash flows.

Annual CF = (p *success*)(180) + (p *failure*)(30) = (0.5)(180) + (0.5)(30) = **$105**

Static NPV_0 = -1100 + 105/0.1 = -1100 + 1050 = **-$50**

Using this incomplete model, the project is rejected due to the negative NPV.

The current value of the option to abandon the project next year is the difference between the dynamic and static NPVs.

Value of Option to abandon = 40.91 - (-50) = **$90.91**

IV. Some Types of Real Options

- Option to abandon: already examined here,
- Option to expand: often valuable if demand may be greater than expected.
- Option to delay: often valuable if market conditions indicate a positive trend.

---

[1] Many students want to know exactly when a project should be abandoned. A project should be abandoned when its liquidation (salvage) value is greater than the PV of the remaining project cash flows. In this example: at t=1 the project can be abandoned for $500 salvage value, and, as a result, the perpetuity of $30 cash flows is lost. Here, r=10%, so as long as the perpetual cash flows are less than $50 per year (where PV = 50/0.1 = $500), the project should be abandoned.