# Capital Budgeting: Distribution Moments

(Welch, Chapter 13-1)

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# Expected Cash Flows

# Value of Graduate Degree

- Life is not fair. At age 25,
  - male life expectancy is about 52.5 years,
  - female life expectancy is about 57 years.
- If you expect to earn $100,000 per year **extra** because of your degree, and
- if the applicable interest rate / (opportunity) cost of capital is 5%/year, then what is your degree really worth?

# Expectation of Function

- Is $E(f[x]) = f[E(x)]$ ?

- Where could this even matter?
- How would you figure out the answer for yourself?

# Expectation Cooking

- **Cook up as simple an example as possible!**
  - Say, you can expect to live one of three lengths, with equal probabilities of 0, 1, and 2 years.
  - Say, the interest rate is 10%.
  - What is the correct expected value of $1 as long as you live?

# Simple Stew I

$$E(CF(t)) = 1/3 \times (\$1 + \$1/1.1 + \$1/1.1^2)$$

$$+1/3 \times (\$1 + \$1/1.1) + 1/3 \times (\$1)$$

$$= \$1.88 \ .$$

- However, if you lived the expected number of years, you would receive

$$CF(E(t)) = \$1 + \$1/1.1 = \$1.91 \ .$$

# Simple Stew II

- Non-linearities in E(CF) matter greatly in insurance, annuities, etc.
- But non-linearities also matter when machines can wear out.
- Sometimes they are first-order important. Sometimes approximations are reasonable. Tough to know beforehand!

# Drug-Dealing

- You expect to earn \$300,000/year. Holding money for a drug-dealer would earn you an extra \$100,000 per year. It is highly unlikely that you will get caught—maybe 1 in 1,000. 999 out of 1,000 times, you earn 25% more.

- $.999 \times \$400 + .001 \times \$0 \approx \$400$ .

# Bad Example

- OK, drug-dealing was a bad example but it illustrated the possibility of a rare bad outcomes with terrible payoffs.
- More commonly, there is a small probability of disaster where you lose all. The manager dies. An explosion happens. etc.
- It is rare that rare events are positive surprises.