Lesson 14-2 – Quantifying and Evaluating Risk

Risk

- Risk is the chance of getting an outcome other than the expected value.
- A common measure is standard deviation:

$$\sigma = \sqrt{[EV(X - mean)^2]}$$

- Standard deviation is used instead of variance because standard deviation is in the same unit as the expected value.

Side Note: What is Standard Deviation (SD)

- Standard deviation, σ is a measure that is used to quantify the amount of variation or dispersion of a set of data values
- A low standard deviation indicates that the data points tend to be very close to the mean (the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values.
- In finance, standard deviation is applied to the annual rate of return of an investment to measure the investment's volatility. Standard deviation is also known as historical volatility and is used by investors as a gauge for the amount of expected volatility.

Risk

- Can be written as

$$\sigma = \sqrt{Outcome A^2 * P(A) + Outcome B^2 * P(B) + \cdots - EV^2]} \quad]$$

Standard Deviations – Simple Example

		EAUB	**Probability**	**Variance**	
		$ 1,000	0.2	$	200,000
		$ 2,000	0.2	$	800,000
		$ 3,000	0.2	$	1,800,000
		$ 4,000	0.2	$	3,200,000
		$ 5,000	0.2	$	5,000,000
Expected EAUB		**$3,000**		$	9,000,000
		Standard Deviation		**$**	**1,414**

Variance = (Outcome1)^2*P(1) = $1000^2*0.2 = $200,000

Standard Deviation = SQRT(Variance 1 + Variance 2 + … + Variance 5 – EV^2)
= SQRT(200000 + 800000 + … + 5000000 - $3000^2)
= $1414

Simple Example (cont'd)

		EAUB	**Probability**	**Variance**
		$ 1,000	0.4	$ 400,000
		$ -	0	$ -
		$ 3,000	0.2	$ 1,800,000
		$ -	0	$ -
		$ 5,000	0.4	$ 10,000,000
Expected EAUB		**$ 3,000**		$ 9,000,000
		Standard Deviation		**$ 1,789**

Oil Example

- What is the standard deviation from our previous oil exploration example

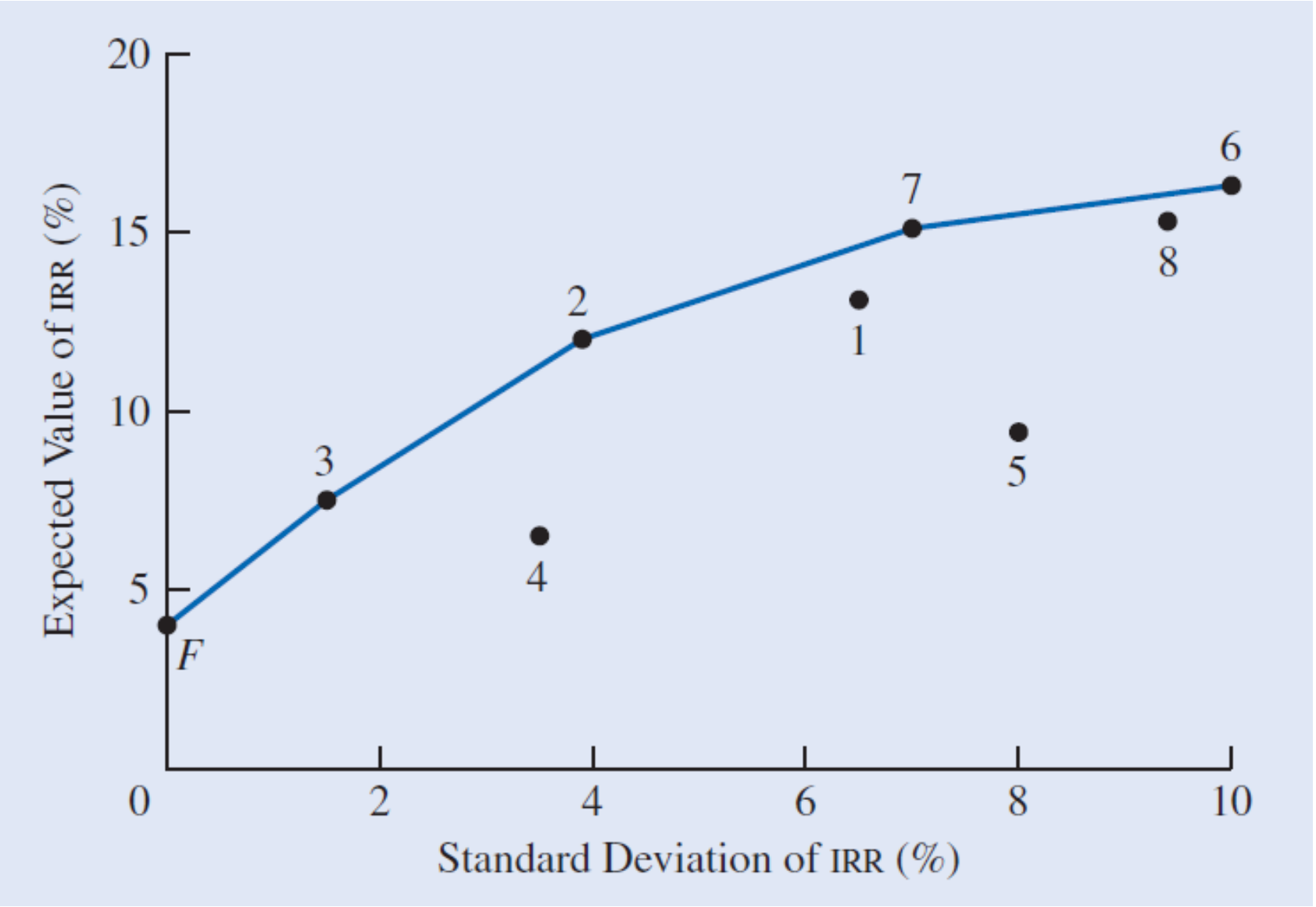
Case	P(case)	NPV(Case)	Variance
Dry Well, Low Price	28%	-$700,000	$137200000000
Dry Well, High Price	42%	-$700,000	$205800000000
Productive Well, Low Price	10%	$177,105	$3136618103
Productive Well, High Price	15%	$469,474	$33060875501
Very Productive Well, Low Price	2%	$1,177,800	$27744256800
Very Productive Well, High Price	3%	$1,803,733	$97603582059
Total Expected Value:	100%	-$324,200 (ENPV)	$105105640000

- Standard Deviation = SQRT(SUM(variance) – Total EV^2) = SQRT($504545332463 – 105105640000) = **$632,014**

Risk versus Return

- Graphing Risk versus Return is one way to consider these items together.
- Risk, measured by standard deviation: σ, is put on the *x*-axis.
- Return, measured by expected value: EV, is put on the *y*-axis.
- Normally done with internal rate of return of the alternatives.
- Rule of Thumb: If the expected present worth is at least double the standard deviation of the present worth, then the project is relatively safe.

Risk versus Return: Example 10-14



Risk versus Return: Example 10-14, cont'd

- It is easily seen from the graph that projects F,3,2,7,and 6 are the projects to select based on the tolerance to risk that an organization has.
- As you move to the right, higher returns are shown but higher deviations are also indicated.
- The other projects are dominated or inferior to the projects connected by the line.

Oil Exploration

- Suppose we had a few better fields to choose from
  - Field 1: Expected Rate of Return 8%, standard deviation 5%
  - Field 2: Expected Rate of Return 14%, standard deviation 10%
  - Field 3: Expected Rate of Return 9%, standard deviation 3%
  - Field 4: Expected Rate of Return: 5%, standard deviation 1%
  - Field 5: Expected Rate of Return 4%, standard deviation 2%