Economic Risk and Decision Analysis for Oil and Gas Industry
CE81.9008

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Project Screening by Dominance

Investments Criteria

Maximum return

If the return is ***risk-free (certain)*****,** all investors prefer the **higher return**

Maximum expected return

If two risky assets have the ***same variance*** of the returns, risk-averse investors prefer the one with the **higher expected return***

Minimum variance of the return

If two risky assets have the ***same expected return***, risk-averse investors prefer the one with the **lower variance of return***

Risk aversion

Investors prefer a **certain dollar** to a lottery with an **expected return** of one dollar

Mean-Variance Criterion

Chose the investment with the **lower variance of return** and **higher expected return**

Mean-Variance Criterion

- **Decision maker** may use **EMV** and **standard deviation** to screen or rank alternatives
- **Mean-variance approach** favored by some risk-averse decision makers seeks to choose alternative that yields **highest expected return** with **lowest variance**

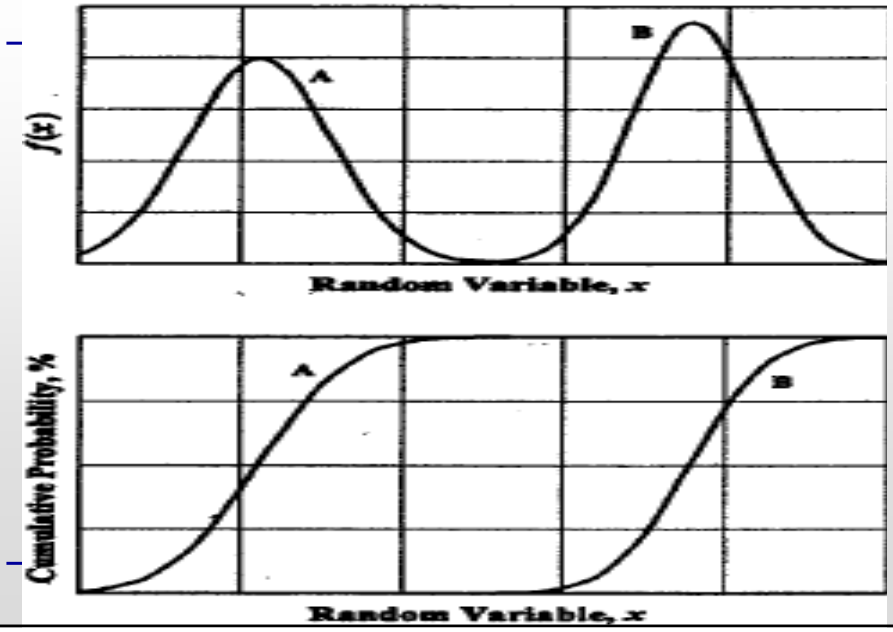
Mean-Standard Deviation Screening Method

- Approach more appropriate when **probability distribution** of each alternative can be **represented** by **mean and standard deviation**
  - Normal distribution good example of appropriate distribution
- When distribution **not** described completely by mean and standard deviation, best to compare distributions themselves

Dominance

- When we can compare **pdf** and **cdf** of alternatives, we can use **dominance rules** to choose between alternatives
- Situations include
- **Deterministic dominance** – **pdf's**, **cdf's**, don't intersect, one alternative always better
- **First degree stochastic dominance** – **pdf's** intersect, **cdf's** don't, one alternative still clear choice over other
- **Second degree stochastic dominance** – less clear

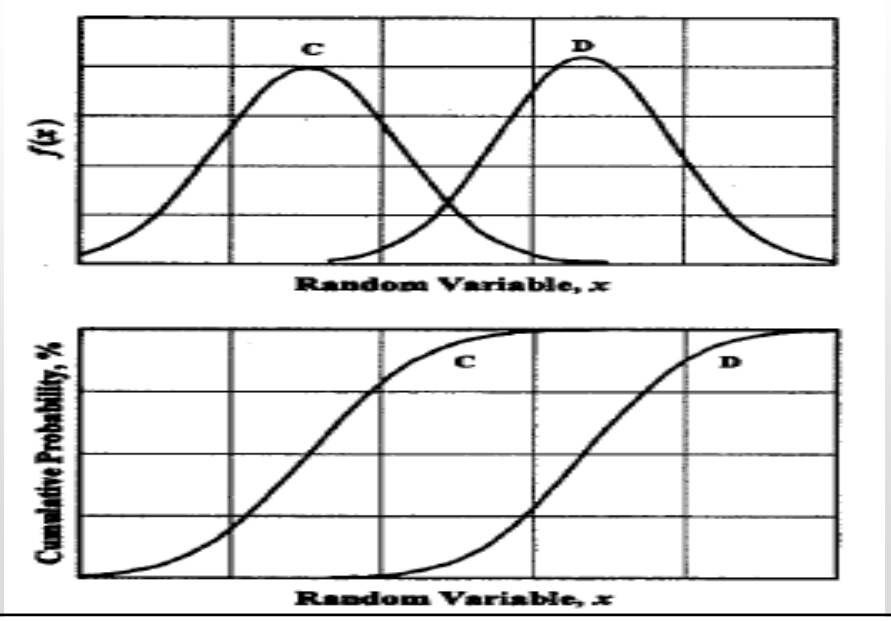
Deterministic Dominance



Deterministic Dominance

- The **PDF** of alternative B is **always to the right** of the PDF of alternative A.
- PDF for the two investment alternatives A and B **do not intersect**.
- Therefore, alternative A is **clearly dominated** by alternative B
- The EMV of B being **certainly higher** than A
- This situation is referred to as ***deterministic dominance***.
- Alternative B has a **higher expected mean** and lower expected S.D. (mean-variance criteria)
- In this case, alternatives are ranked based on **maximized EMV**.

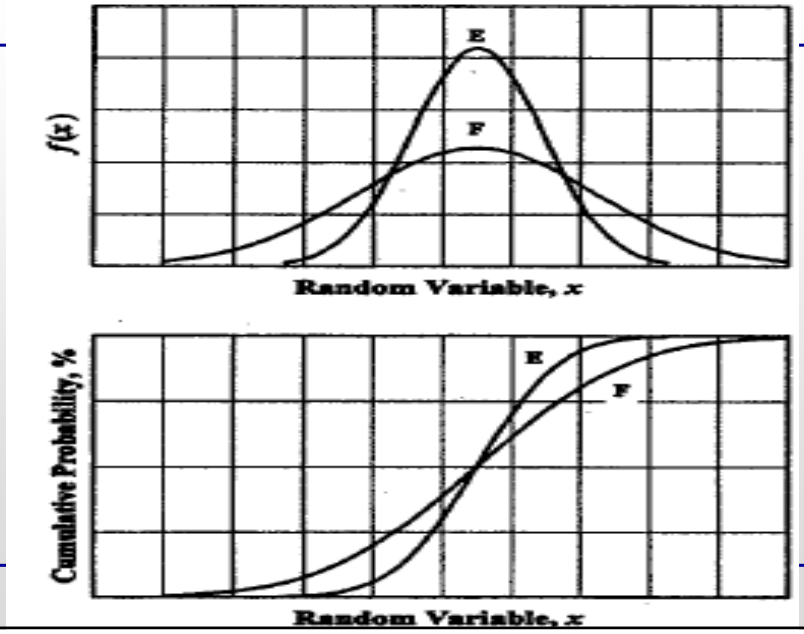
First-Degree Stochastic Dominance (FSD)



First-Degree Stochastic Dominance (FSD)

- **PDF** of two investments **do intersect**
- But the corresponding **CDF do not intersect**, then a condition of ***first degree stochastic dominance*** exists.
- It cannot be said *with certainty* one alternative will produce higher EMV than the other
- However, it can be said that for all EMVs alternative D is *more likely* to exceed the EMV of C
- Alternatives in this case may be ranked based on **maximized EMV.**

More Complex Situation



Second-Degree Stochastic Dominance (SSD)

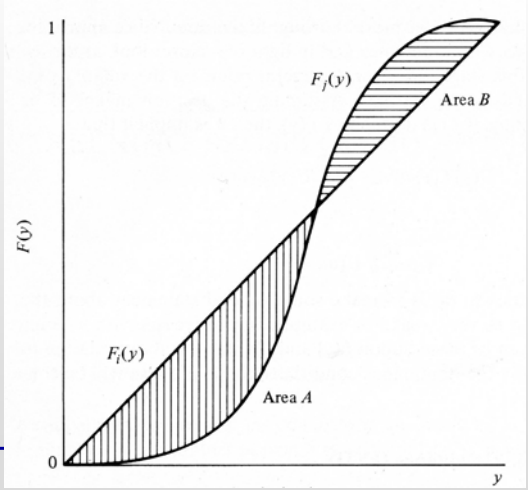
- Both the **PDFs** and their corresponding **CDFs** of alternatives **intersect**.
- If the alternatives have the **same expected value**, but the S.D. of alternative F is more than the S.D. of alternative E. Therefore, alternative **F is more risky**.
- The **CDF** shows up to the **point of crossover**, investment E dominated investment F while after the crossover point investment F dominates investment E.
- This situation is called **second-degree stochastic dominance**
- Comparison of **the areas between the F dominated part** and the **E dominated part** will give the overall extent of dominance. The part with the larger area is the dominating investment.

Second-Degree Stochastic Dominance (SSD)

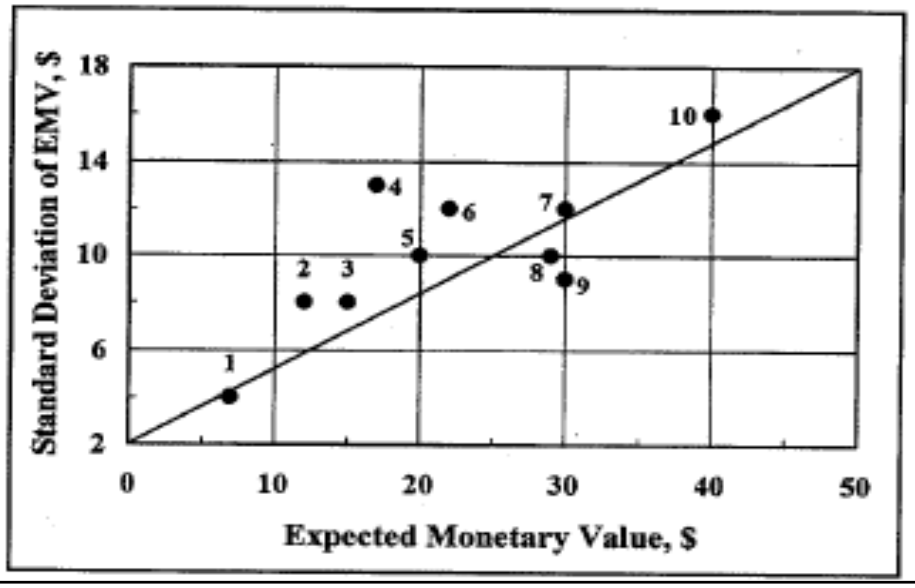
Alternative a_j dominates a_i in the sense of SSD if

$$\int_{-\infty}^{z} [F_i(y) - F_j(y)]dy \geq 0$$

for all z over y.



Mean-Standard Deviation Screening Method



Mean-Standard Deviation Screening Method

- Investments 1, 7, 8, 9, and 10 provide greater EMV for given level of risk than other investment opportunities
  - Determines **“efficient frontier”**
- Choice between investments depends on **how risk averse** decision maker is
  - Investment 10 offers greatest reward, but is highest risk

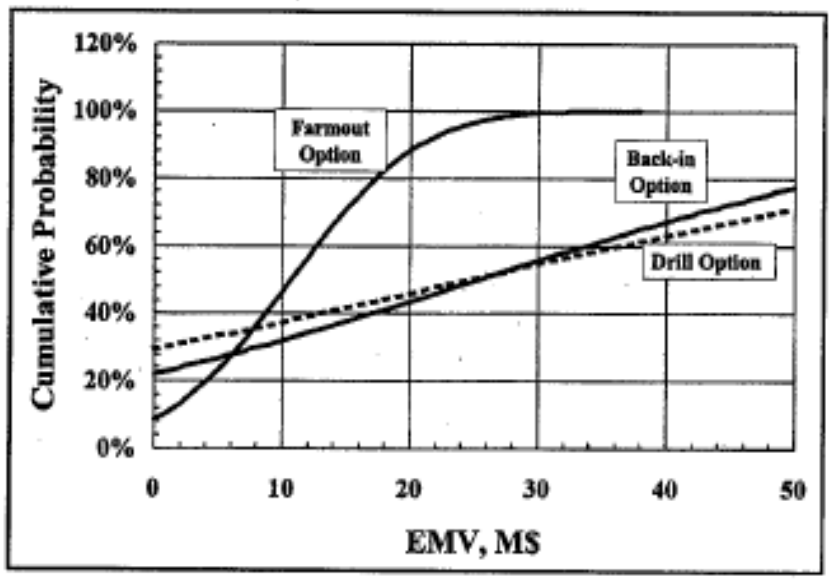
Application of Dominance Rules

Out-come State	Proba-bility	Drill with 37.5%		Farm out with ORI		Back in with 37.5%	
		NPV	EMV	NPV	EMV	NPV	EMV
Dry hole	0.25	-30.000	-7.500	0	0	0	0
20 MSTB	0.30	4.357	1.307	8.733	2.620	0.750	0.225
35 MSTB	0.25	45.448	11.362	14.646	3.662	34.142	8.536
50 MSTB	0.15	87.411	13.112	20.693	3.104	73.712	11.057
65 MSTB	0.05	125.863	6.293	26.401	1.320	111.141	5.557
EMV, M$			24.574		10.706		**25.375**
Standard deviation, M$			**45.622**		7.809		32.869

Application of Dominance Rules

- Assume normal distributions for each case
  - Allows use of EMV, standard deviation to generate **cdf**

Application of Dominance Rules



Application of Dominance Rules

- **Back-in option** dominates drill option for 0<EMV<$27M
- **Drill option** dominates back-in option for EMV>$27M
- **Area dominated by back-in option** slightly larger than area dominated by drill option
  - Back-in option has ***second-degree stochastic dominance*** over drill option