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

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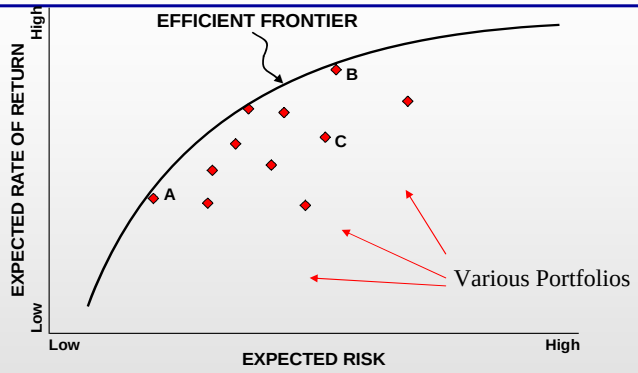
Efficient Frontier

- Risk vs. Reward Portfolio Approach
- Criteria Depend on Objectives of the Firm
- Maximize Return, Minimize Risk within Certain Parameter Constraints
  - Drilling Budget, Success Rate, Exposure to Loss, Production Rate, Seismic Costs etc.
- Select Optimum Portfolio

Efficient Frontier



The efficient frontier: **that set of opportunities that has the maximum return for every given level of risk, or minimum risk for every level of return**

Every opportunity on the frontier has either higher return for equal risk or lower risk for equal return than some portfolio beneath the frontier

Portfolio Example

- An oil company has $10 million to invest in exploration and production projects.
- Only two projects are available and each requires the full $10 million for 100% interest.
- One project is relatively “safe”; the other relatively “risky”.
- The chances of success are independent.

Safe vs. Risky Projects

	Outcome	NPV ($million)	Independent Probability (%)
SAFE	Dry hole	-10	40
	Success	50	60
RISKY	Dry hole	-10	60
	Success	80	40

The EMVs of each project are the same:
EMVsafe=60%*$50+40%*($-10)=$26 million
EMVrisky=40%*$80+60%*($-10)=$26 million

Shareholder Confidence

- If money is lost, shareholder confidence is forfeited.
- There is a 40% chance of forfeiting shareholder confidence with the safe project, and a 60% chance with the risky project.
- Since the EMV for both projects is $26 million, there is no way of increasing that by choosing the risky over the safe project.
- Under both circumstances the safe project is obviously the better choice.

Share Working Interest

- Suppose it is possible to split the investment evenly between the two projects.
- Intuitively it would seem a bad idea to take a 50% out of the safe project and put it into the risky one.
- There are now four possible outcomes and these are shown below.

Diversification Effect

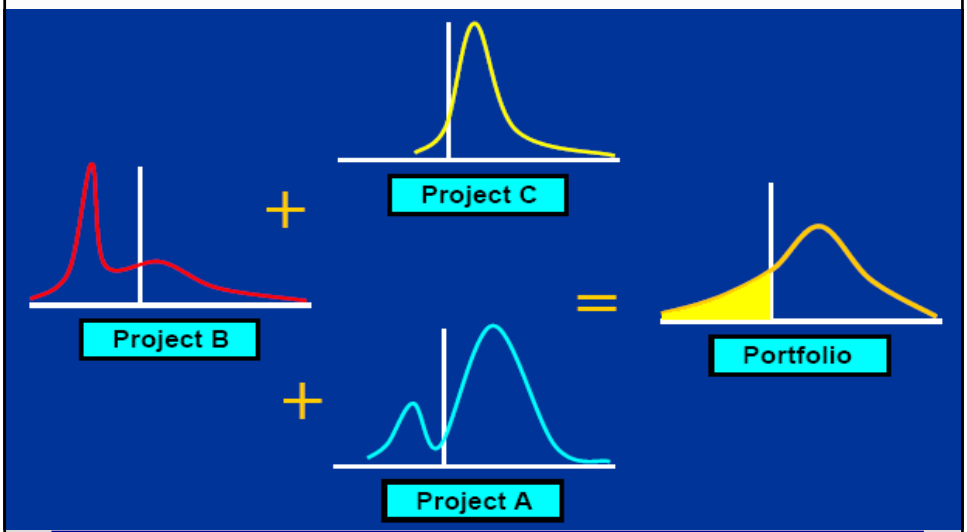
SCENARIO	SAFE	RISKY	PROBABILITY	RETURN($million)	RESULT
1	Success	Success	0.6*0.4=0.24	50%*$50+50%*$80=$65	Shareholder confidence retained
2	Success	Dry hole	0.6*0.6=0.36	50%*$50+50%*($-10)=$20	Shareholder confidence retained
3	Dry hole	Success	0.4*0.4=0.16	50%*($10)+50%*($80)=$35	Shareholder confidence retained
4	Dry hole	Success	0.4*0.4=0.24	50%*(-$10)+50%*(-$10)=-$10	Shareholder confidence lost

• The EMV of portfolio is still $26 million
(24% *$65+36%*$20+16%*$35+24%*(-$10)=$26 million)
• But the only way to forfeit shareholder confidence is Scenario 4 ,for which the probability is 24%.
• So, **moving money from a safe project to a risky one, which, seems counter-intuitive, reduces risk and is the effect of diversification.**

Diversification Effect

- Most companies (that do not use portfolio theory) rank their exploration projects based on EMV and then choose the project with the highest EMV.
- This **ignores the diversification effect** and in the example above would have led to allocating all the funds to the safe project, with nearly twice the risk of the best portfolio.

Modern Portfolio Theory

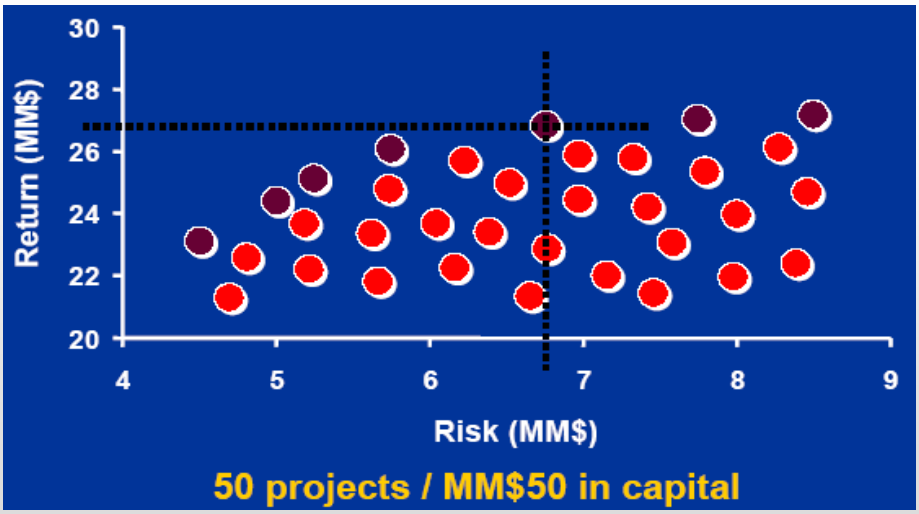


Optimizer determines participation percent

Iteration	Explore 1	Mature 3	Dtree 5	Develop 2A	Develop 2B	Portfolio
1	-2,481	950	-597	1,353	289	-545
2	-2,481	950	-597	571	383	-482
3	-2,481	950	-597	1,350	794	-206
4	9,607	950	3,966	1,103	547	9,094
5	-2,481	950	-597	534	348	-505
6	5,308	950	-597	596	51	3,190
7	-2,481	950	4,928	310	216	3,550
.	.	.	.	.	.	.
.	.	.	.	.	.	.
499	3,125	950	-597	653	501	2,400
500	950	950	1,388	939	224	2,616
Xi =>	50%	100%	75%	0%	67%	Avg NPV 2,124

Typical constraints:
"Must Do" "Optional" "Range of Acceptable"

Portfolio Optimization



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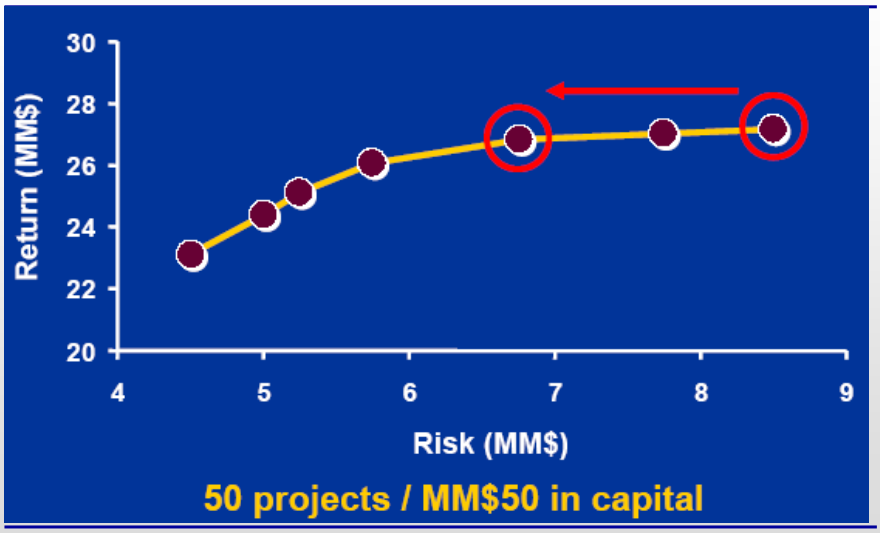

Portfolio Optimization