
Improving E&P Performance through Advances in Risk and Portfolio Management

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Understanding the Decision Problem



Risk Management and Financial Theory

- ◆ *Owner wealth maximization*
 - Maximize NPV or $E(\text{NPV})$

- ◆ *Modern Portfolio Theory*
 - Mean-variance analysis.
 - Concern is with non-diversifiable risk only.
 - Corporate resources devoted to managing business risks are inappropriately utilized.
 - However, corporations appear to take risk management very seriously!!

- ◆ *Real Options Analysis*
 - Valuing managerial flexibility
 - “private” vs. market risks

Diversification and Portfolio Analysis

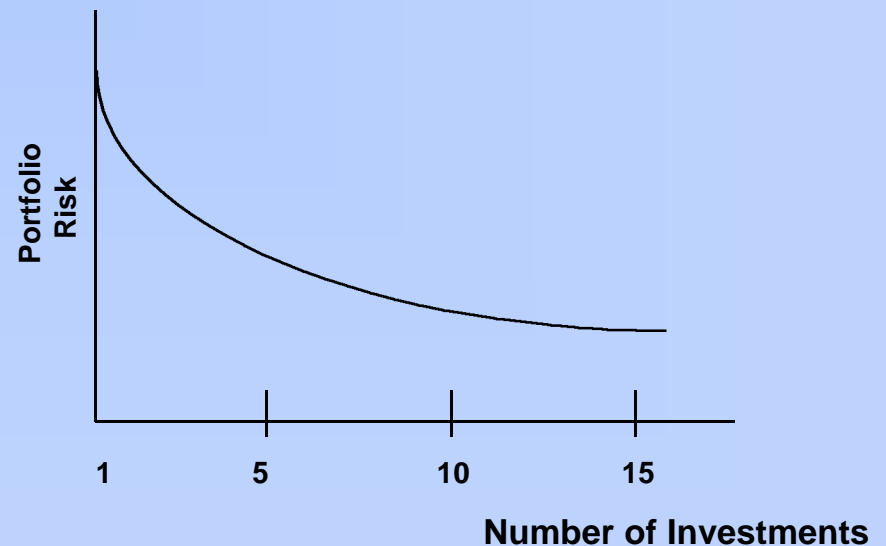
- ◆ *An integral part of business and capital markets*
 - The stock investor diversifies by investing in many stocks.
 - Insurance companies “share” risk through a reinsurance market.
 - Joint ventures between companies to develop new products.
 - Joint ventures among integrated and independent oil firms.

- ◆ *Motivations for Corporate Diversification*
 - Risk-averse investors avoid unnecessary risk.
 - Differing expectations concerning project success
 - Diversification against the loss of resources resulting from unsuccessful projects.
 - Desire for more consistent and steady long-run returns.

Diversification

- ◆ **Basic Assumption: Decisions are based on a trade-off between risk and return.**
 - Return is measured by expected value.
 - Risk is measured by the variance or standard deviation.
- ◆ **Diversification works to reduce risk because returns of different investments do not move exactly together.**
- ◆ **Even in a two investment portfolio, a decline in the value of one investment can be offset by an increase in the value of the other investment.**

Result: Variability of portfolio is less than the average variability of the two investments in the portfolio.



Portfolio Analysis

- ◆ Expected Return: weighted average of the expected returns on the individual investments contained in the portfolio.

$$E(r_p) = \sum_{j=1}^n x_j E(r_j)$$

where x_j is the percent of investment in j .

- Variance: function of the variance of each investment included in the portfolio as well as the covariance between investments' returns.

$$\mathbf{s}_p^2 = x_i^2 \mathbf{s}_i^2 + x_j^2 \mathbf{s}_j^2 + 2 x_i x_j \mathbf{r}_{i,j} \mathbf{s}_i \mathbf{s}_j$$

where,

x_i = % of portfolio invested in asset i

\mathbf{s}_i^2 = variance of returns on asset i

ρ_{ij} = correlation coefficient between assets i & j

Current Portfolio Analysis

Portfolio Analysis

	<u>EXPLORATION</u>		<u>DEVELOPMENT</u>		NPV At 9% (\$000)	Original Participation Level	Original Portfolio Weight	Revised Participation Level	Revised Portfolio Weight	Revised Total Cost	Original Total Cost
	DRILL COS (%)	Net Explr Capex* (\$000)	DRILL COS (%)	Net Dev Capex (\$000)							
Prospects											
Prospect 1	70.0%	\$12,750	100.0%	\$9,921	\$45,749	25.0%	20.3%	25.0%	20.3%	\$19,695	\$19,695
Prospect 2	33.3%	\$22,500	67.0%	\$45,000	\$247,109	75.0%	33.5%	75.0%	33.5%	\$32,540	\$32,540
Prospect 3	33.0%	\$4,250	50.0%	\$6,000	\$49,050	40.0%	5.4%	40.0%	5.4%	\$5,240	\$5,240
Prospect 4	65.0%	\$21,750	80.0%	\$16,000	\$39,016	80.0%	30.9%	80.0%	30.9%	\$30,070	\$30,070
Prospect 5	50.0%	\$2,500	90.0%	\$5,000	\$17,645	25.0%	4.9%	25.0%	4.9%	\$4,750	\$4,750
Prospect 6	66.0%	\$3,500	85.0%	\$2,500	\$9,440	60.0%	5.0%	60.0%	5.0%	\$4,903	\$4,903
							100.0%		100.0%	\$97,197	\$97,197

Portfolio Variance: 2,027,862,553
 Portfolio Std. Dev.: \$45,032

Covariance Matrix

	Prospect #1	Prospect #2	Prospect #3	Prospect #4	Prospect #5	Prospect #6
Prospect #1	31,058,749	23,586,820	597,490	4,351,924	273,639	174,926
Prospect #2	23,586,820	1,791,244,268	4,537,491	33,049,641	2,078,086	1,328,430
Prospect #3	597,490	4,537,491	1,149,415	837,197	52,641	33,651
Prospect #4	4,351,924	33,049,641	837,197	60,978,773	383,421	245,104
Prospect #5	273,639	2,078,086	52,641	383,421	241,086	15,412
Prospect #6	174,926	1,328,430	33,651	245,104	15,412	98,520

Optimization Reduces Portfolio Risk

Portfolio Analysis

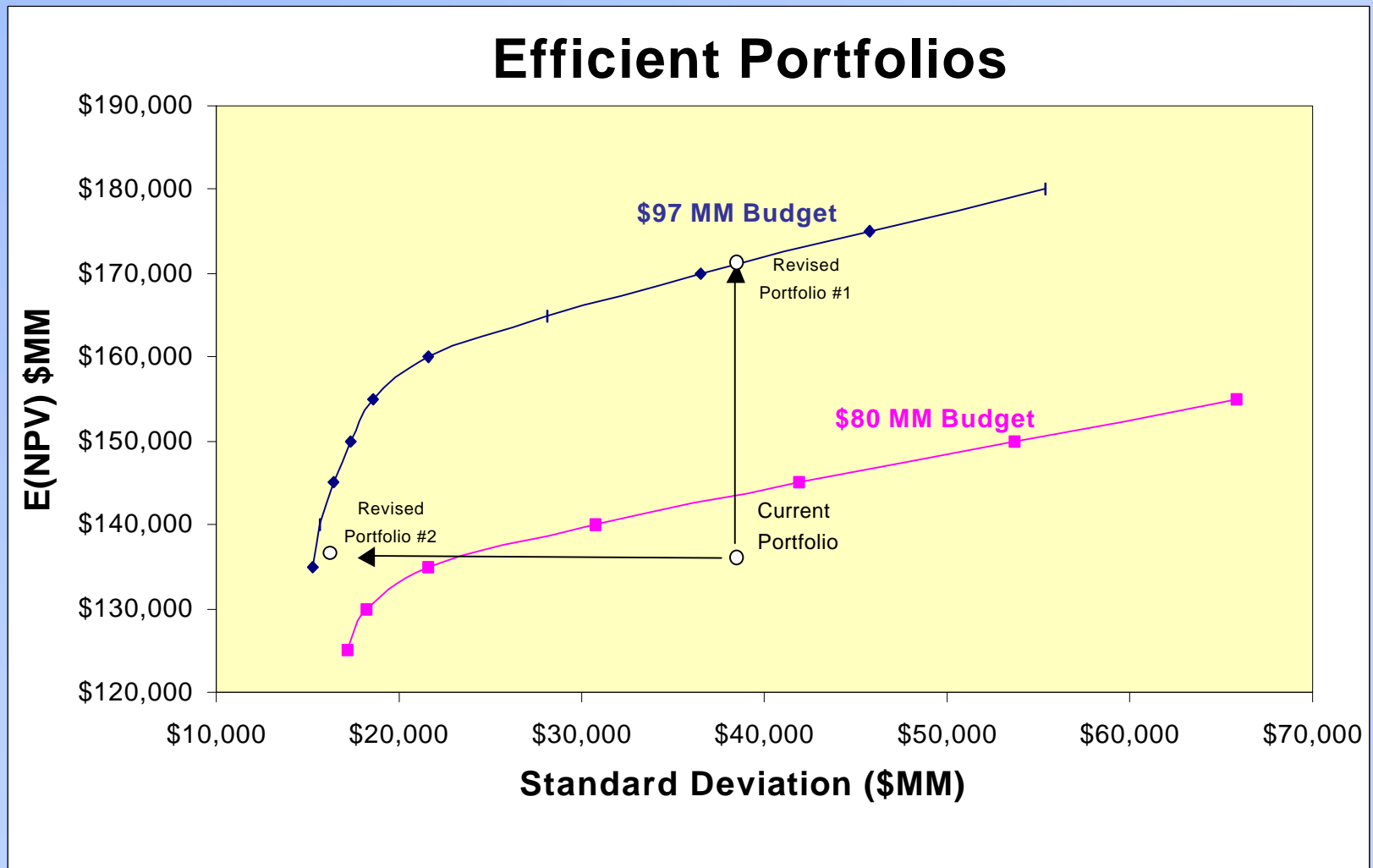
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Prospect 2	33.3%	\$22,500	67.0%	\$45,000	\$247,109	75.0%	33.5%	20.0%	8.9%	\$8,677	\$32,540
Prospect 3	33.0%	\$4,250	50.0%	\$6,000	\$49,050	40.0%	5.4%	75.0%	10.1%	\$9,825	\$5,240
Prospect 4	65.0%	\$21,750	80.0%	\$16,000	\$39,016	80.0%	30.9%	51.9%	20.1%	\$19,505	\$30,070
Prospect 5	50.0%	\$2,500	90.0%	\$5,000	\$17,645	25.0%	4.9%	100.0%	19.5%	\$19,000	\$4,750
Prospect 6	66.0%	\$3,500	85.0%	\$2,500	\$9,440	60.0%	5.0%	100.0%	8.4%	\$8,171	\$4,903
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Portfolio Variance: 308,425,621
Portfolio Std. Dev.: \$17,562

Covariance Matrix

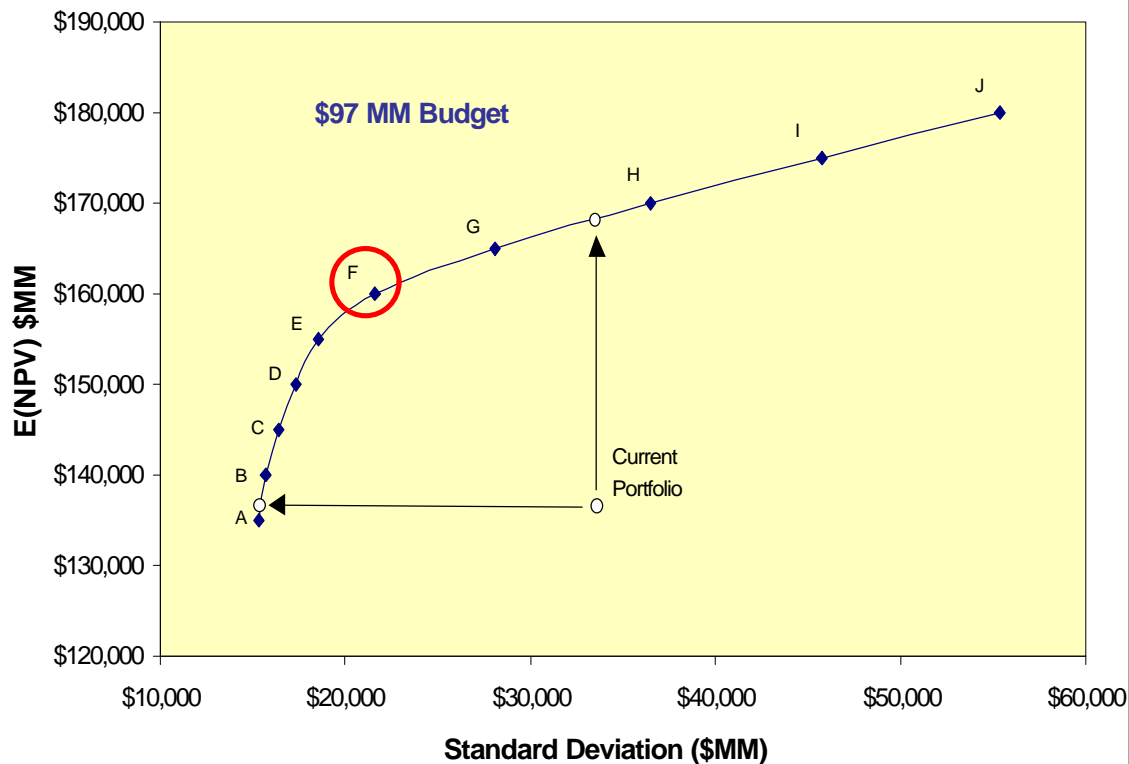
	Prospect #1	Prospect #2	Prospect #3	Prospect #4	Prospect #5	Prospect #6
Prospect #1	82,093,683	10,225,903	1,821,357	4,589,313	1,779,515	473,986
Prospect #2	10,225,903	127,377,763	2,268,753	5,716,624	2,216,631	590,415
Prospect #3	1,821,357	2,268,753	4,040,923	1,018,200	394,809	105,160
Prospect #4	4,589,313	5,716,624	1,018,200	25,655,808	994,809	264,974
Prospect #5	1,779,515	2,216,631	394,809	994,809	3,857,388	102,744
Prospect #6	473,986	590,415	105,160	264,974	102,744	273,666

Frontier Defines Efficient Set



Risk Tolerance and the Optimal Portfolio

Efficient Portfolios



Certainty Equivalent (Cx) Analysis
 Firm's Risk Tolerance: \$12.5 million

Portfolios	Portfolio Measures		
	Std. Dev.	E(NPV)	Cx
A	\$15,322	\$135,000	\$125,609
B	\$15,700	\$140,000	\$130,140
C	\$16,389	\$145,000	\$134,256
D	\$17,353	\$150,000	\$137,955
E	\$18,550	\$155,000	\$141,236
F	\$21,632	\$160,000	\$141,282
G	\$28,100	\$165,000	\$133,416
H	\$36,475	\$170,000	\$116,783
I	\$45,720	\$175,000	\$91,387
J	\$55,403	\$180,000	\$57,220

$$C_x = EV - \frac{S^2}{2RT}$$



Firm can now identify the “optimal” portfolio among the efficient set - matching risk taking with risk characteristics.



Integrating Strategy and Capital Allocation

- ◆ *Provides a means to identify and evaluate a larger set of decision opportunities or exploration projects.*
- ◆ *Links opportunities and decisions with E&P firm's objectives and goals.*
- ◆ *Formalizes the risk analysis process such that the firm can select projects consistent with its risk tolerance.*
- ◆ *Provides a means to evaluate the firm's position relative to its strategic plan.*
- ◆ *Improves the overall quality of investment and operating decisions which will ultimately create value for the firm.*

Enables the E&P firm to act on their corporate and business strategies.