EXPLORATION AND PRODUCTION (E&P)

How to Choose and Manage Exploration and Production Projects

Term Project

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DEFINITION

What is E&P

E&P is the business of finding Petroleum or Gas and getting out of the ground

Why choose E&P

Because it is a risky business and most E&P projects fail while a few are successful

THE UNCERTAINTIES OF E&P PROJECTS ARE DIVIDED INTO 2 CATEGORIES

Local uncertainties

- Involve the discovery and production of oil&gas at the site such as
  - Place

Global uncertainties

- Involve outside conditions such as
  - Prices and costs
  - Change and demand or transportation system
  - Change in technology of exploration
  - Change in regulation

OBJECTIVES OF THE PROJECT

1. Understand how to **quantify the risk of the E&P projects and entire portfolio of producing properties**, including diversification effects

2. Understand how to **manage the risk and find the best diversification strategy** (optimization portfolio)

DATA SET

Obtaining the **NPV and Costs** of total 7 projects A-G

- Each of them have **different physical properties**

PROPERTIES OF THE EXAMPLE PROJECTS

	Project						
	A	B	C	D	E	F	G
Produced Fluid	Oil	Oil	Oil	Oil	Gas	Gas	Gas
Scale of example	Well	Well	Well	Well	8 Wells	4 Wells	8 Wells
Location	Gulf Coast	Calif.	W. Texas	Alberta	Mid-Cont.	Alberta	Gulf Coast
MEAN PROPERTIES							
Area, acres	160	160	160	160	320	640	640
Thickness, feet	25	15	8	20	29.8	13.3	21.8
Porosity, %	13	22	20	13	21.7	14.2	24.3
Initial Hydrocarbon saturation	75	60	75	78	67	56	62
Permeability, mD	13	200	25	15	288	172	258
Depth, feet	5500	5500	5500	5500	3637	6960	13372
Oil Viscosity, cP	10	50	2	15	n/a	n/a	n/a
Temperature, °F	n/a	n/a	n/a	n/a	100	198	287
Initial pressure, psi	2382	2382	2382	2382	966	2053	5787
Price assumptions ($/unit)	15	15	15	15	2	2	2

DETAILS OF PROJECT

- Total **140 scenarios of correlated data set have been generated** from the sources we obtained
- Then, we also using **@risk to generate another 10,000 scenarios**

FUNDAMENTAL CONCEPTS THAT WE USED FROM THE CLASS

1. **LP Optimization Modeling -** budget & capital allocation problem
2. **Risk and Uncertainties Modeling**
3. **Goal Programming**

APPLIED CONCEPTS THAT WE USED

1. Conventional Approach
2. Markowitz Model
3. Mean Absolute Deviation

1. CONVENTIONAL APPROACH

Decision rule, those with highest NPV/I was selected until the capital budget was exhausted

Maximize $\Sigma P_i X_i$ (Maximize return)

Subject to $\Sigma C_i X_i \leq B$ (Budget Constraint)

$X_i \leq 1$

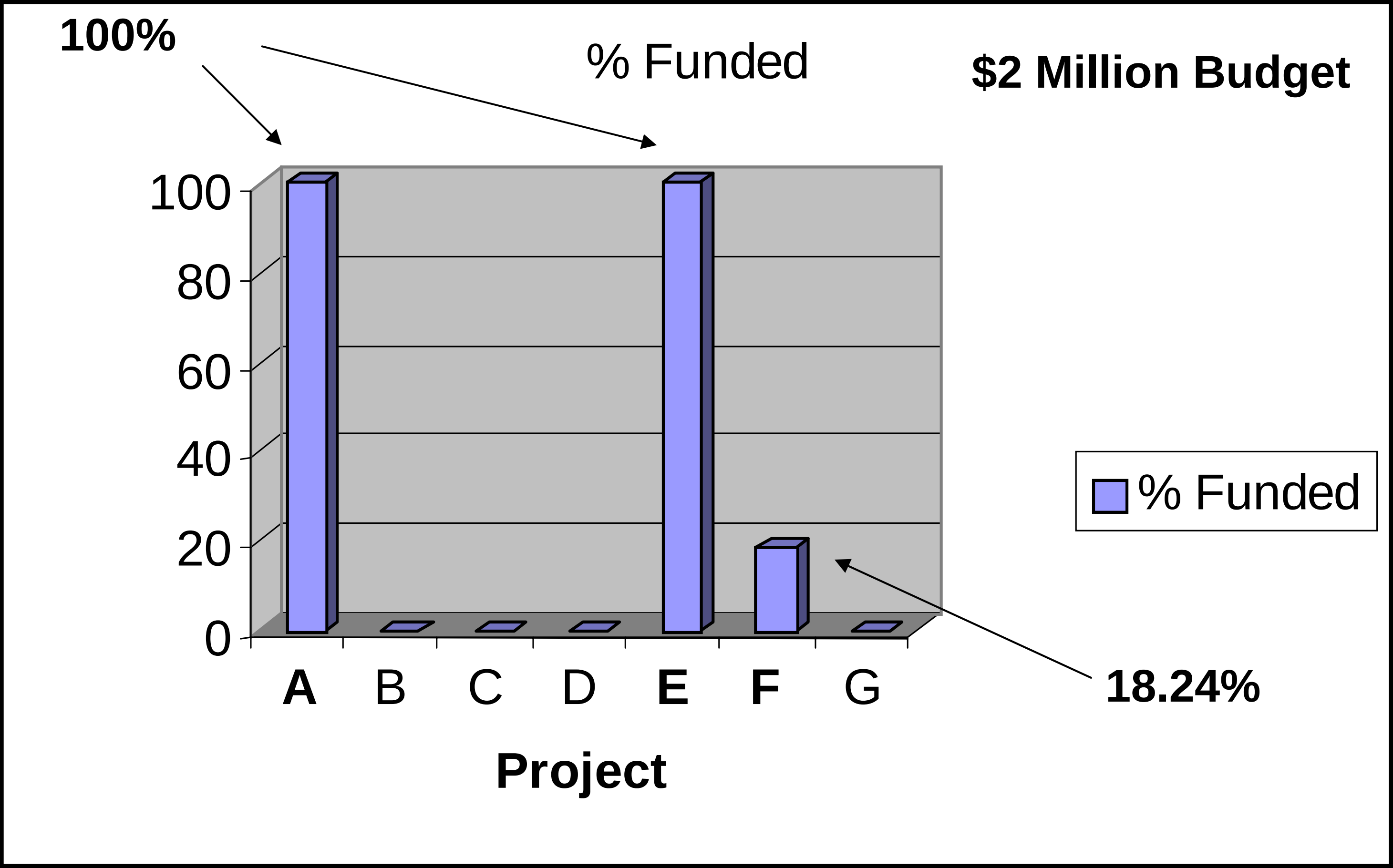
$X_i \geq 0$

P_i = NPV or Return of project i

X_i = % funded for project i (x100)

B = Capital Budget

CONVENTIONAL APPROACH RESULT (1/2)



CONVENTIONAL APPROACH RESULT (2/2)

Project	% Funded (x100%)	Investment x$1000	NPVx$1000	Costs x$1000
A	**1**	**$442.72**	**$121.40**	**$442.72**
B	0	$413.21	$9.36	$0.00
C	0	$203.44	-$67.07	$0.00
D	0	$442.72	-$0.59	$0.00
E	**1**	**$1,284.00**	**$507.43**	**$1,284.00**
F	**0.182429906**	**$1,498.00**	**$46.92**	**$273.28**
G	0	$12,911.00	-$606.40	$0.00
			total investment	**$2,000.00**

2. MARKOWITZ MODEL (1/2)

- **The model embodies Harry Markowitz's original expression for risk return trade-off**

- **The risk is measured by the variance and using the input of expected return and full covariance matrix of assets**

- **Using the concept of Efficient Frontier**
  - Each point on the efficient frontier has minimized the risk for that level of expected return
  - The best portfolios are those according to the point on the efficient frontier itself

MARKOWITZ MODEL (2/2)

Minimize $\sigma^2 = XQX^t$ (Min Variance)

S.T. 1) $\Sigma x_i = 1$ (Budget constraint)

2) $\Sigma r_i x_i \geq E$ (Expected return of at least E)

3) $x_i \geq 0$

x_i = % of portfolio in asset i (Weight of asset i)

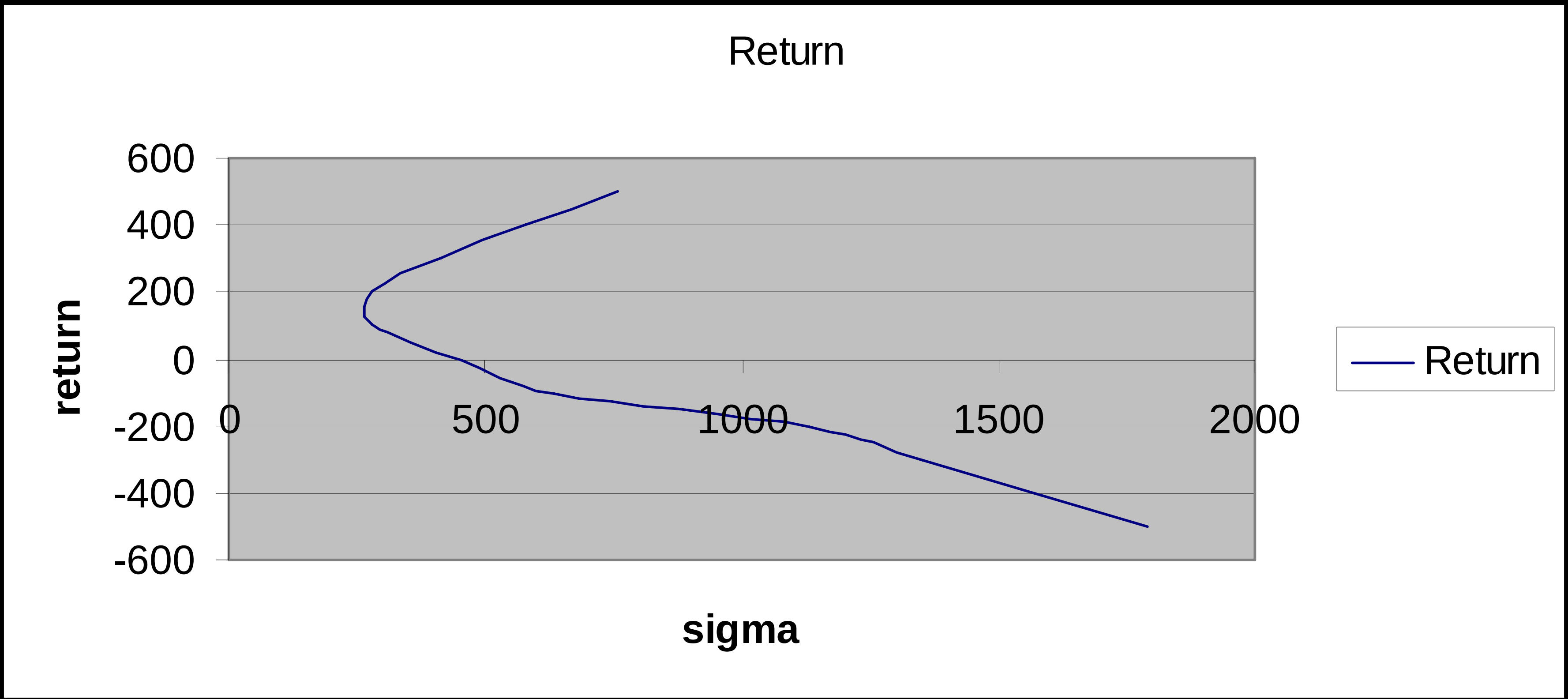
Q = Covariance Matrix

r_i = Expected return of I th asset

MARKOWITZ MODEL RESULT (1/2)

Return	W1	W2	W3	W4	W5	W6	W7	Risk(VAR)	STDV
-500	0.01257578	0.0106398	0	0.012599	0.0192461	0.01128888	0.833060773	3206159.9	1790.58
-400	0.1175359	0	0	0	0.0714145	0.00122409	0.734705717	2469340.9	1571.41
-300	0.19293003	0	0	0	0.1254139	0	0.632898716	1823042.5	1350.2
-200	0.26716866	0	0	0	0.1794624	0	0.530998939	1284973.1	1133.57
-100	0.53171141	0	0	0	0	0.18279143	0.285497164	402754.85	634.63
0	0.59254296	0	0	0	0.0564161	0.17190714	0.179133802	205423.38	453.237
100	0.28137845	0.0126813	0	0.023878	0.1801173	0.41452871	0.072770439	78360.737	279.93
200	0.18461819	0.1529808	0	0.128939	0.3283365	0.2051258	0	77422.723	278.249
300	0.22602936	0.0416349	0	0	0.516406	0.21592973	0	173106.27	416.06
400	0.19048333	0	0	0	0.7359105	0.07360616	0	332168.93	576.341
500	0.01924347	0	0	0	0.9807565	0	0	573190.25	757.093
600	0	0	0	0	1	0	0	595209.79	771.498

MARKOWITZ MODEL RESULT (2/2)



3. MEAN ABSOLUTE DEVIATION (MAD) (1/3)

- MAD is an alternative measure of risk that is sometimes advantageous over variance. This model contrasts with the Markowitz in some ways

- It measures risk in term of mean absolute deviation instead of variance

MEAN ABSOLUTE DEVIATION (MAD) (2/3)

- The MAD model is linear as opposed to non-linear of Markowitz model and that can take the full advantage of large scale Linear Programming (LP) code
- It can take scenarios of historical returns or Monte Carlo simulation directly as input instead of using summary statistics.

MEAN ABSOLUTE DEVIATION (MAD) (3/3)

Minimize MAD = Average(y_j)

S.t. 1) Σx_i = 1 (Budget constraint)

2) $\Sigma r_i x_i \geq E$ (Expected return of at least E)

3) $\Sigma s_{ij} x_i - \Sigma r_i x_i \leq y_j$ (Upside of absolute value)

4) $\Sigma r_i x_i - \Sigma s_{ij} x_i \leq y_j$ (Downside of absolute value)

5) $x_i \geq 0$

x_i = % of portfolio in asset i (Weight of asset i)

r_i = Expected return of i th asset

$s_{i\,j}$ = Return of asset i under the j th scenario

y_j = Absolute deviation of the return of the j th scenario from the expected return

MAD WITH MINIMIZE ONLY DOWN SIDE OF RISK

- Modified MAD model to take into by minimizing only the down-sided risks at a single fixed rate of penalties

- Each unit of the downside deviation from the mean will be penalized linearly with certain fixed cost

MAD WITH MULTIPLE PENALTIES

- In addition to case of single fixed cost for down side risk penalty, we then add an additional high penalties cost if the downside deviation are higher than acceptable value

- This model is minimized only the down-sided risks at a multiple fixed rate of penalties

MAD RESULT (1/2)

Return	W1	W2	W3	W4	W5	W6	W7	Yi	rx	variance
-500	**0.07898**	**0.11763**	**0.21709**	**0.434027**	**0.040087**	**0.10734**	**0.00485**	94.50275	18.311	122063.63
-400	**0.07898**	**0.11763**	**0.21709**	**0.434027**	**0.040087**	**0.10734**	**0.00485**	94.50275	18.311	122063.63
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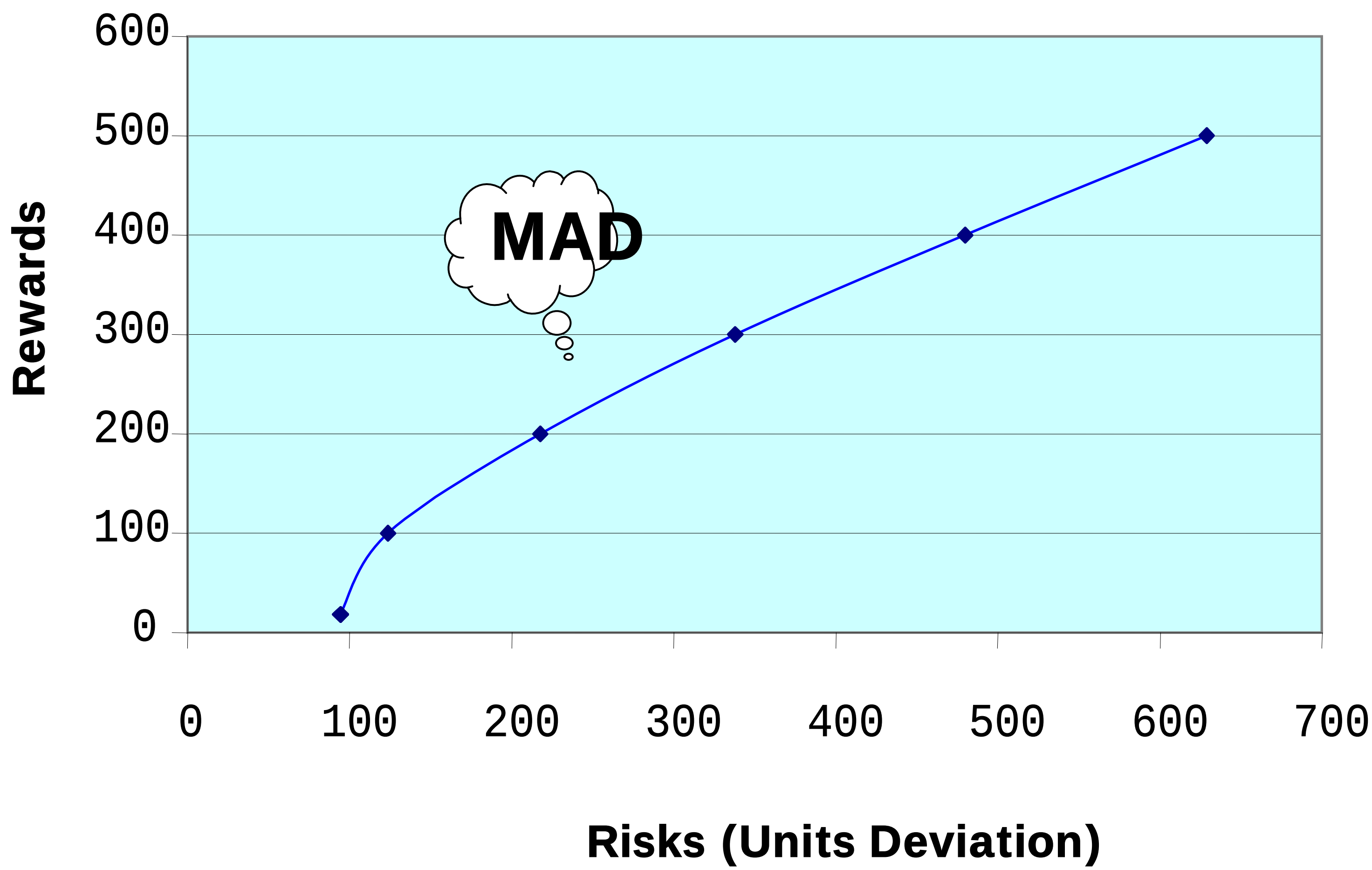
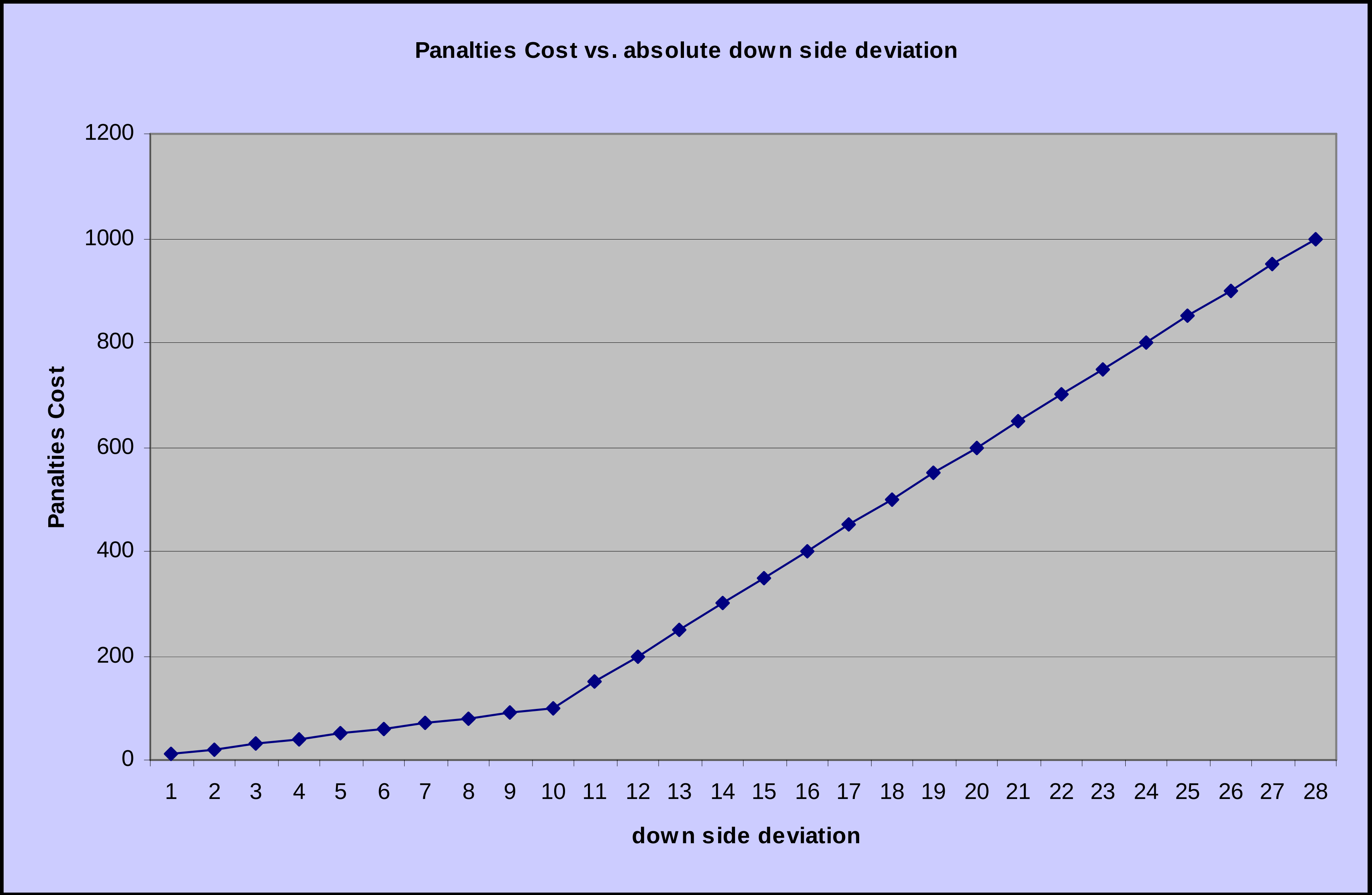
100	**0.11916**	**0.17988**	**0.01911**	**0.408038**	**0.157491**	**0.11632**	**0**	123.8279	**100**	174430.1
200	**0.27817**	**0.20327**	**0**	**0.025623**	**0.306649**	**0.18628**	**0**	217.7918	**200**	304498.86
300	**0.30724**	**0**	**0**	**0**	**0.499876**	**0.19289**	**0**	338.0155	**300**	405039.39
400	**0.12896**	**0**	**0**	**0**	**0.74586**	**0.12518**	**0**	479.7009	**400**	496587.75
500	**0.01924**	**0**	**0**	**0**	**0.980757**	**0**	**0**	628.6596	**500**	588435.23

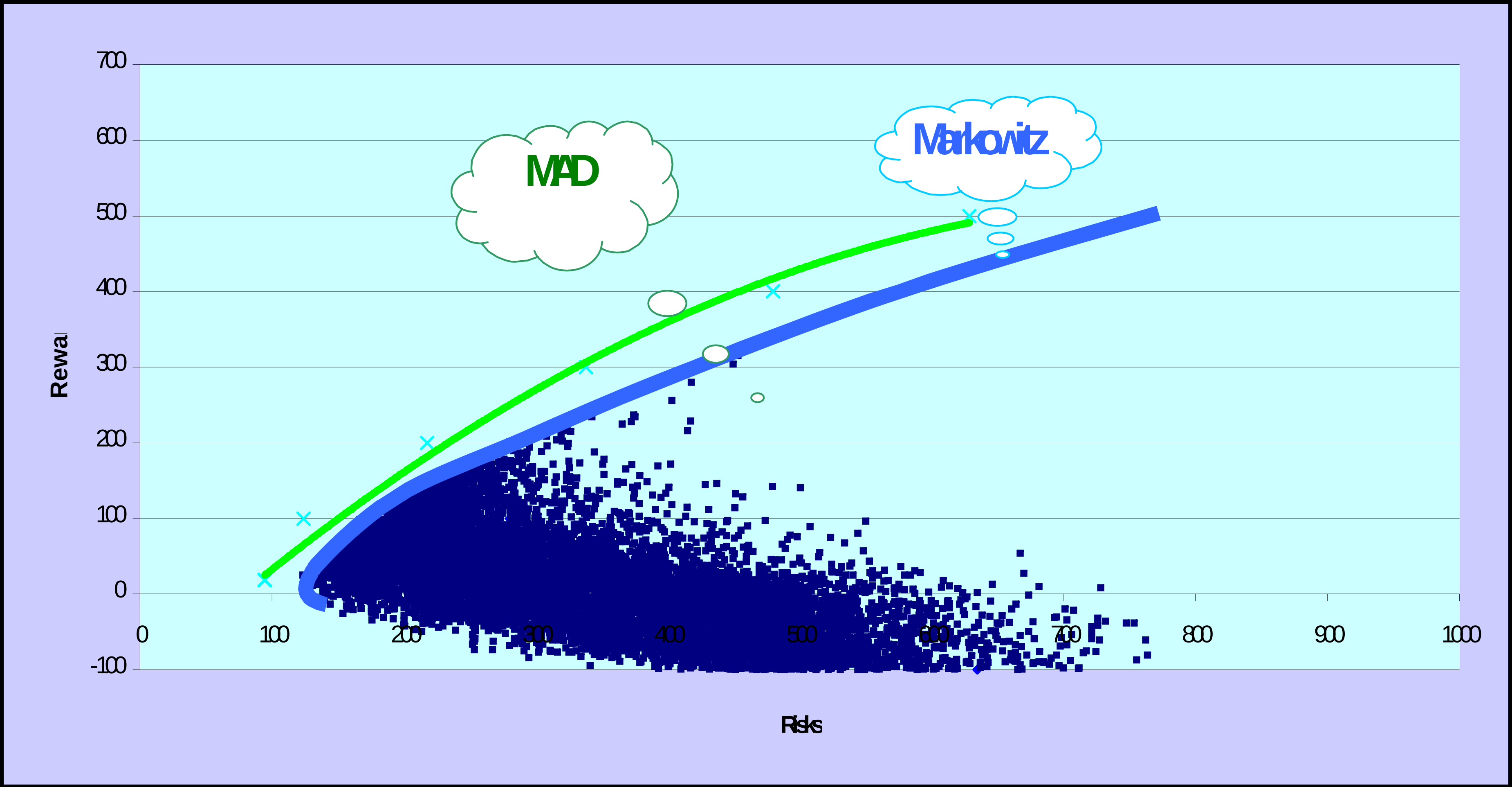
MAD RESULT (2/2)



MAD WITH MULTIPLE PENALTIES RESULT



COMPARISON (BY USING THE SIMULATION DATA)



CONCLUSION (1/2)

- Using the Markowitz model and MAD model, we can see that both methods have accounted the risk into the model while the Conventional method does not

- MAD and Markowitz model provide us better results than conventional method. By looking at the same amount of return of the portfolio, both MAD and Markowitz model give us less risk than the Conventional technique

CONCLUSION (2/2)

- By comparing the Markowitz model with MAD model, the efficient frontier results from these methods are consistent in terms of the weight among each investment

- MAD is the best approach for this kind of data set as the input(Different Scenarios) instead of using summary statistics

FUTURE WORKS

The extended objectives and works would be as follow,

- What should we pay for a new project, given the projects already in our portfolio?
- How would oil projects, as contrasted from gas projects, affect the impact of price uncertainty on my portfolio?

Q &A