Exploration Asset Valuation using Risk Adjusted Values

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How can we explain the disconnect between FMV and EPV (Risked NPV) shown here with two examples of recent exploration transactions in East Africa

- *In July 2012, Vanoil Energy acquired Avana Petroleum for about $15 MM*
  - *Reported Net Expected Present Values for 10% interest in Kenya L9 and 25% in Seychelles A & B were $156 MM and $54 MM respectively, for a total of $210 MM*
  - *Apparently, FMV is 7% of EPV*

- *In September 2011, Horn Petroleum paid Africa Oil $25 MM for Somali interests*
  - *Reported Net Expected Values for 60% interest in each of Nugaal and Dharoor blocks were $2,943 MM (four prospects) and $1,201 MM (three prospects) respectively, for a total of $4,144 MM*
  - *Apparently FMV is 1% of EPV*

Expected Values do not provide a basis for rationalizing exploration portfolio management decisions and opportunity valuations

$$EPV = WI * [(PWs * Ps) - (PVf * Pf)]$$

- *100% WI maximizes EPV*
- *Fair Market Value would approach EPV in an efficient market*

Transaction analysis demonstrates risk aversion

- *Wide range of preferred WI, frequently << 100%*
- *Entry fees paid << EPV*

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Risk Adjusted Values provide a basis for rationalizing exploration portfolio management decisions and opportunity valuations

After Cozzolino,

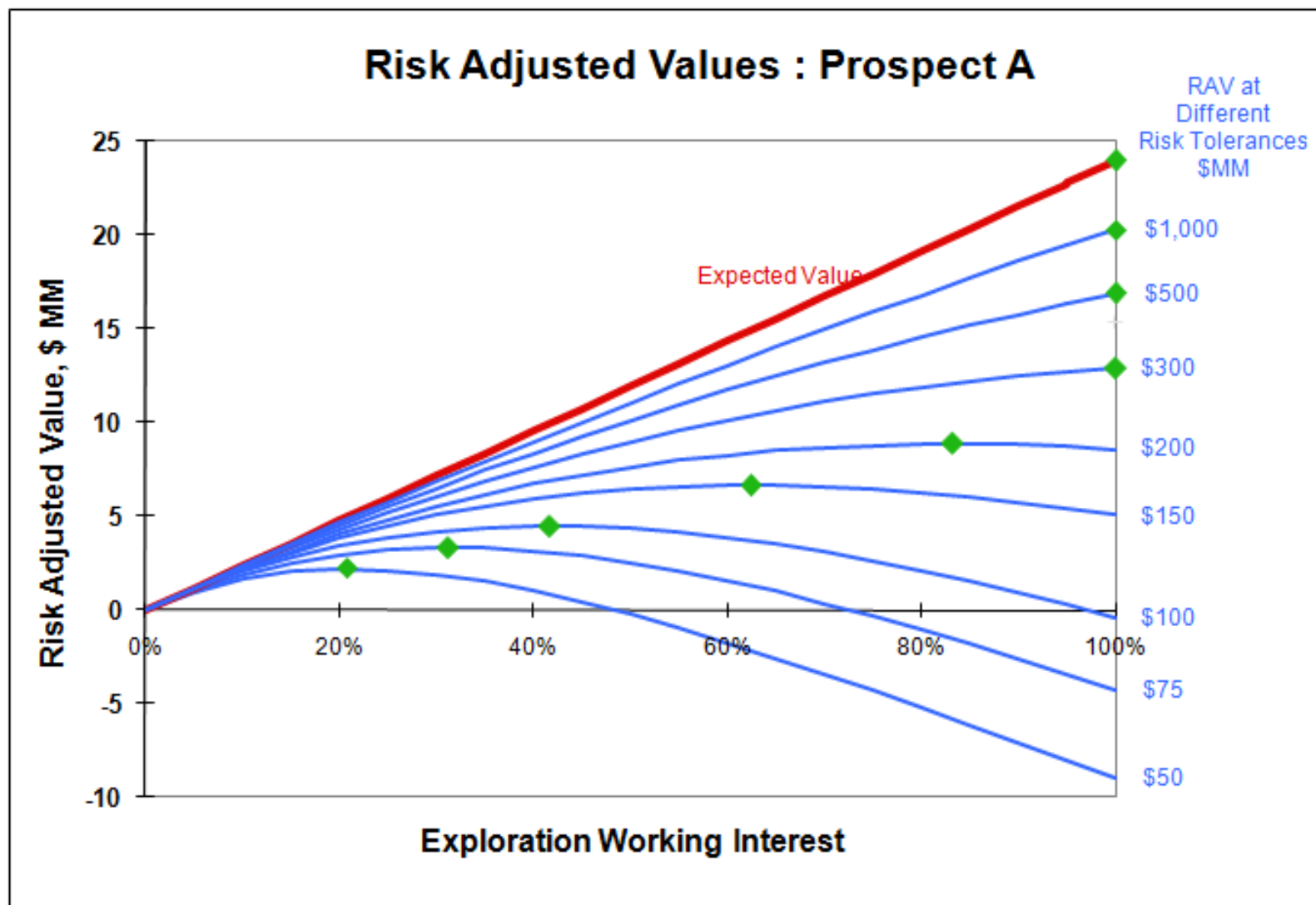$$RAV = -RT * ln\ [(Ps * e^{-WI*PVs/RT}) + (Pf * e^{WI*PVf/RT})]$$

Differentiating with respect to Working Interest , one can derive the Optimum Working Interest (<= 100%) that maximizes RAV

$$OWI = [RT/(PVs + PVf)] * ln\ [(Ps * PVs)/(Pf * PVf)]$$

RAV_{OWI} *is a fraction of EPV (and we use it as a proxy for FMV)*

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Risk Adjusted Values explain observed behaviors
## (OWI less than 100%, RAV less to much less than EPV)

Green Diamonds indicate Optimum Working Interest
(maximum RAV for given RT)

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Although companies do not routinely calculate RAVs, we find the OWI and RAV mimics observed transactions and bidding behavior, here for ARCO International

Risk Adjusted Value Profiles for $70 MM Risk Tolerance
(Diamonds are actual working interests)
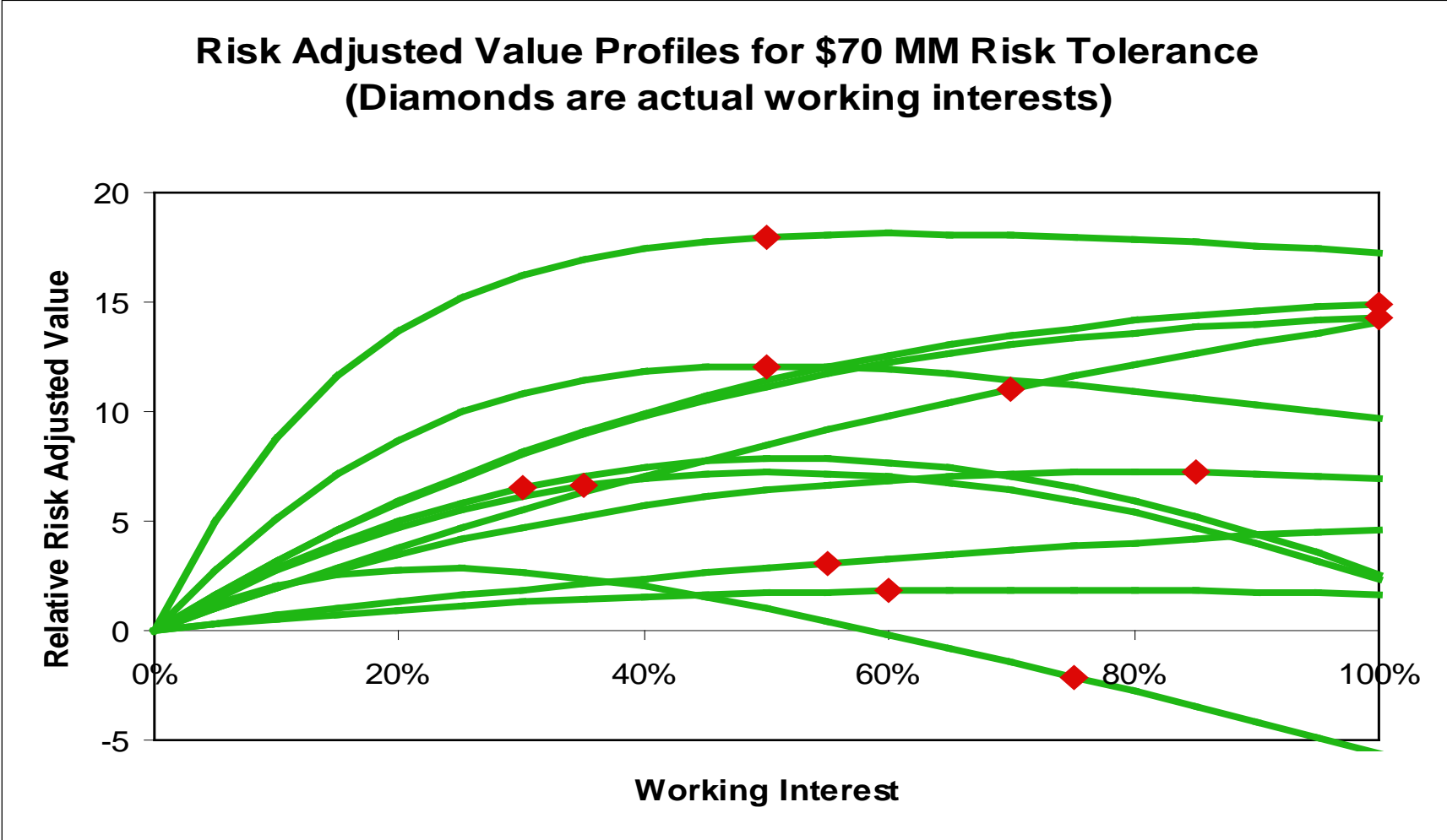
Most properties of RAV are intuitive, except the paradox of aversion to incremental reward. Lerche and Mackay modified Cozzolino's formula but I prefer not to
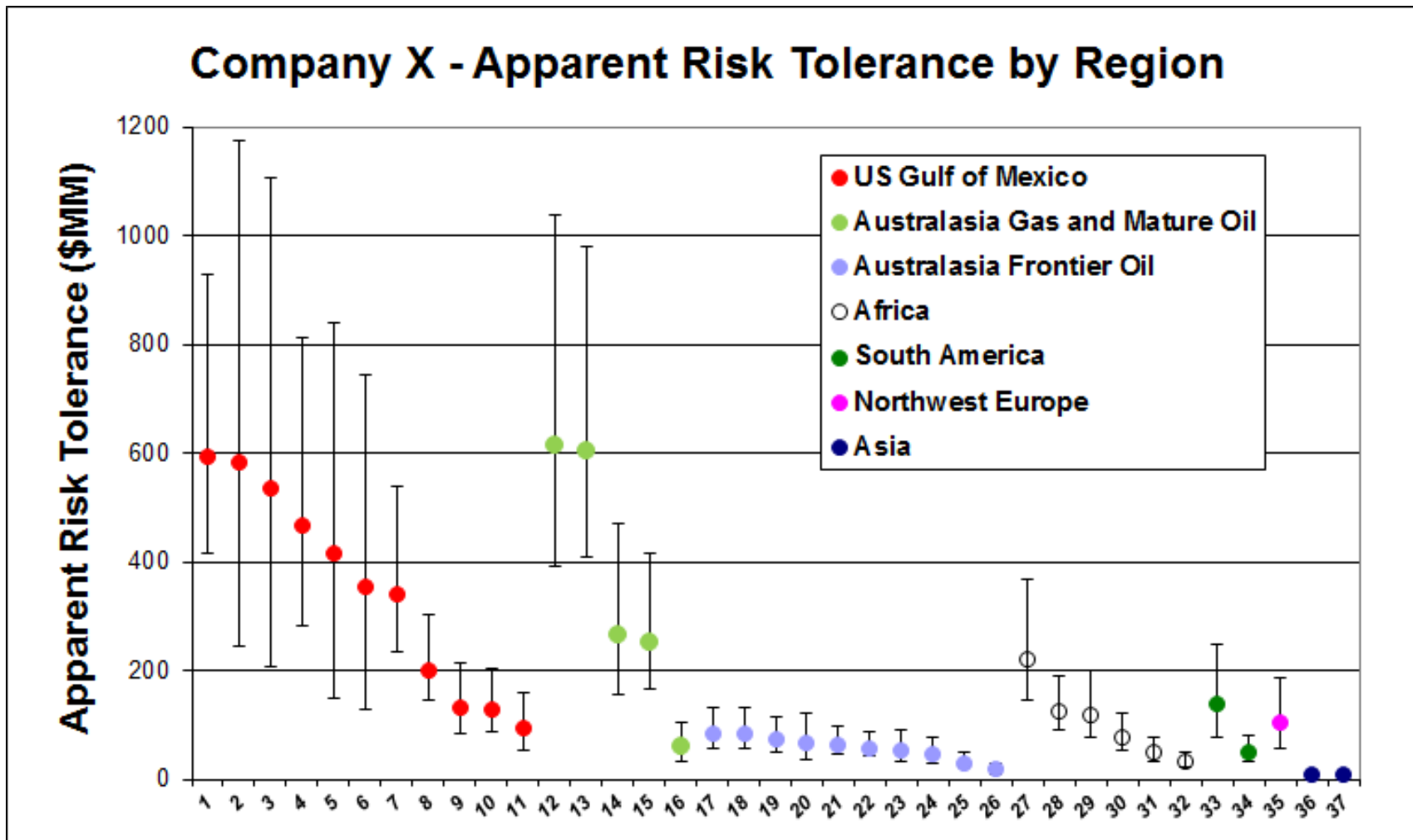
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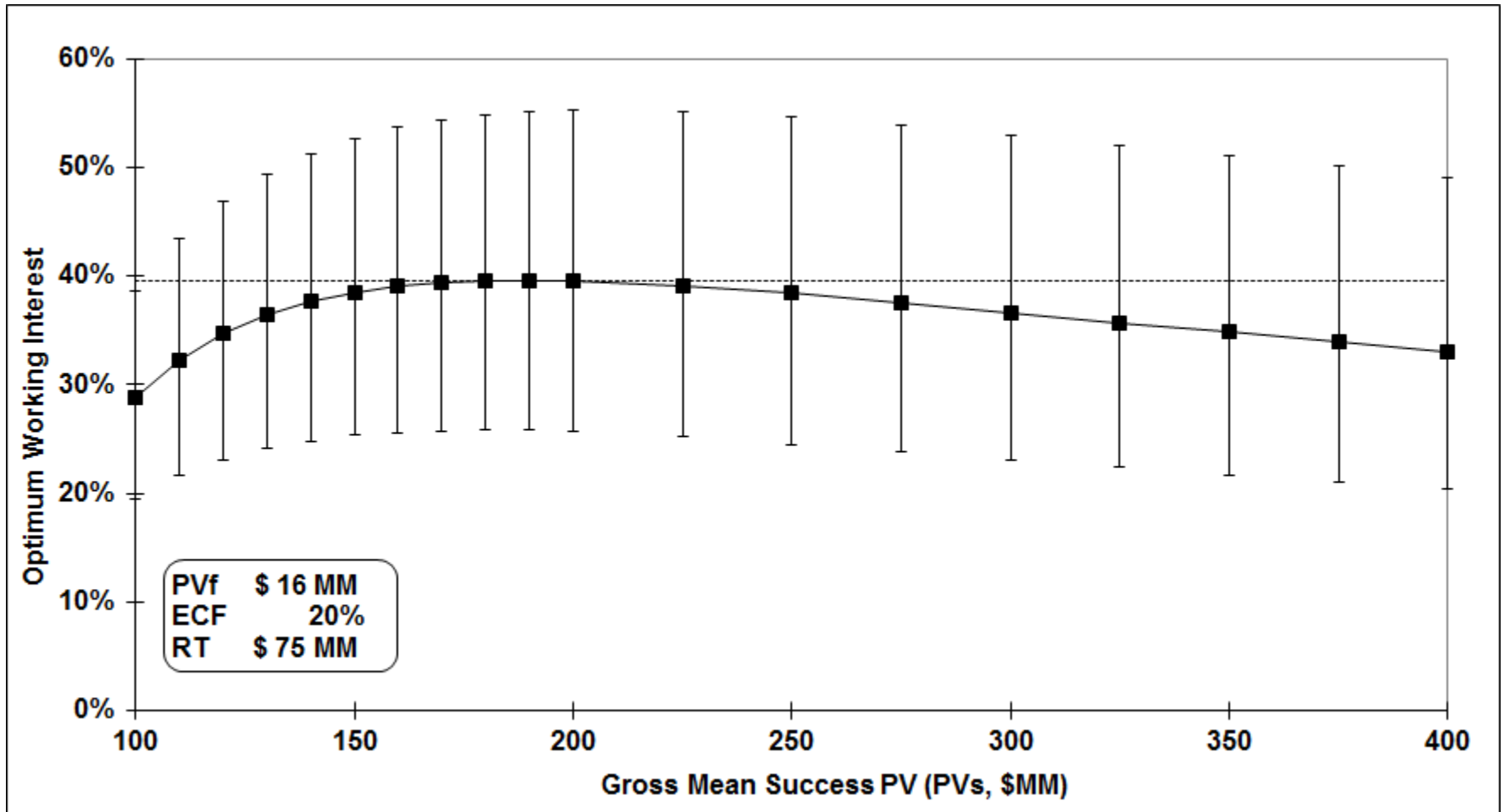
We suspect the lack of enthusiasm for RAV was because there was no rational basis for determining a single portfolio-wide value of RT for a firm

However, setting WI = OWI yields Apparent Risk Tolerance,

$$ART = WI * (PVs + PVf) / \ln [(Ps * PVs)/(Pf * PVf)]$$

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We concluded that RT varies within any firm by business unit or portfolio segment based on (a) strategic direction and (b) surface or country risk

Company X - Apparent Risk Tolerance by Region

Legend:
- US Gulf of Mexico
- Australasia Gas and Mature Oil
- Australasia Frontier Oil
- Africa
- South America
- Northwest Europe
- Asia

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From studies like this, we developed some rules of thumb for assessing RT in the absence of any other data (but prior to the price increases of 2005-2008)

Super Major, low country risk, core area	*$1,000 MM*
Major/Large Independent, low country risk, core area	*$ 500 MM*
Super Major, moderate country risk, non-core	*$ 200 MM*
Large Independent, international core business unit	*$ 100 MM*
Large Independent, frontier and/or high country risk	*$ 50 MM*
Medium independent, frontier and/or high country risk	*$ 20 MM*

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The cumulative RAV for the portfolio of Gulf of Mexico prospects exceeds the sum of the individual prospect RAVs, predicting and quantifying the portfolio effect

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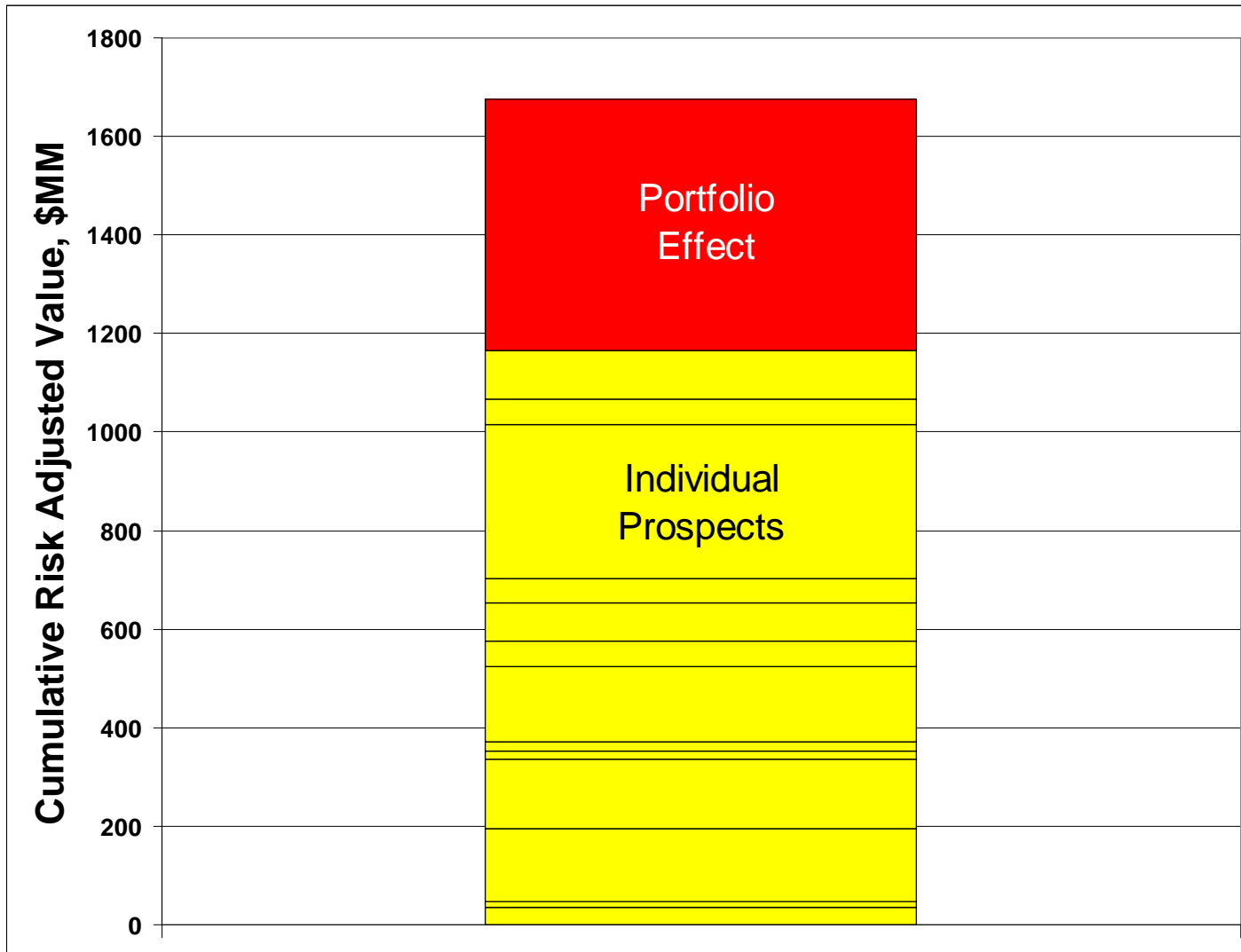
Case Study – Predictive Example - West Africa

- ● **Resources Report available**

		ECF (Ps)	MSR (MMSTB)	MSPVs ($MM)	EPV ($MM)
Prospect 1		39%	166	456	163
Prospect 2		30%	286	592	160
Prospect 3		43%	94	277	106
Prospect 4		51%	75	214	97
Prospect 5		30%	108	316	77
Prospect 6		23%	141	409	75
Prospect 7		17%	116	349	39
Prospect 8		39%	49	111	28
Prospect 9		4%	34	16	-24
Prospect 10		3%	35	22	-24
Total			1103	2763	697

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- *Distinguish between risked and unrisked resources and values*
  - *Obvious, I know, but …*

- *FMV should not include entire prospect inventory*
  - *Need to limit value to prospects drilled in a prudent work program*

- *For RAV, need to take care of dependent probabilities*
  - *EPV is unaffected by dependencies between prospects*
  - *RAV is affected by dependencies between prospects because RAV of portfolio is dominated by overall risk-weighted cost of failure (Pf*PVf)*
  - *Either distinguish play and prospect risks, or run both independent and maximum dependency cases to show sensitivity*

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Predicted Valuation and Actual Outcome

- *Two well program*

	$MM	%EPV
Expected Value, All Prospects with EPV>0	744	
Expected Value, Two Best Prospects	323	
Predicted Gross RAV at OWI	131	41%
Actual Grossed Up Purchase Price	60	19%

- *Prospect Ps were 39% and 30% respectively. Reducing these parameters to 20% and 15% gives Gross RAV of $58 MM*

- *Client wished to retain 50%. Our analysis of the market for potential farminees suggested it would be prudent to target two 25% partners rather than one 50% partner*

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Net RAV versus WI for the farm-in opportunity. RAV at OWI is a straight line, so the "grossed-up" (100% WI) value of the opportunity is constant for all RT.

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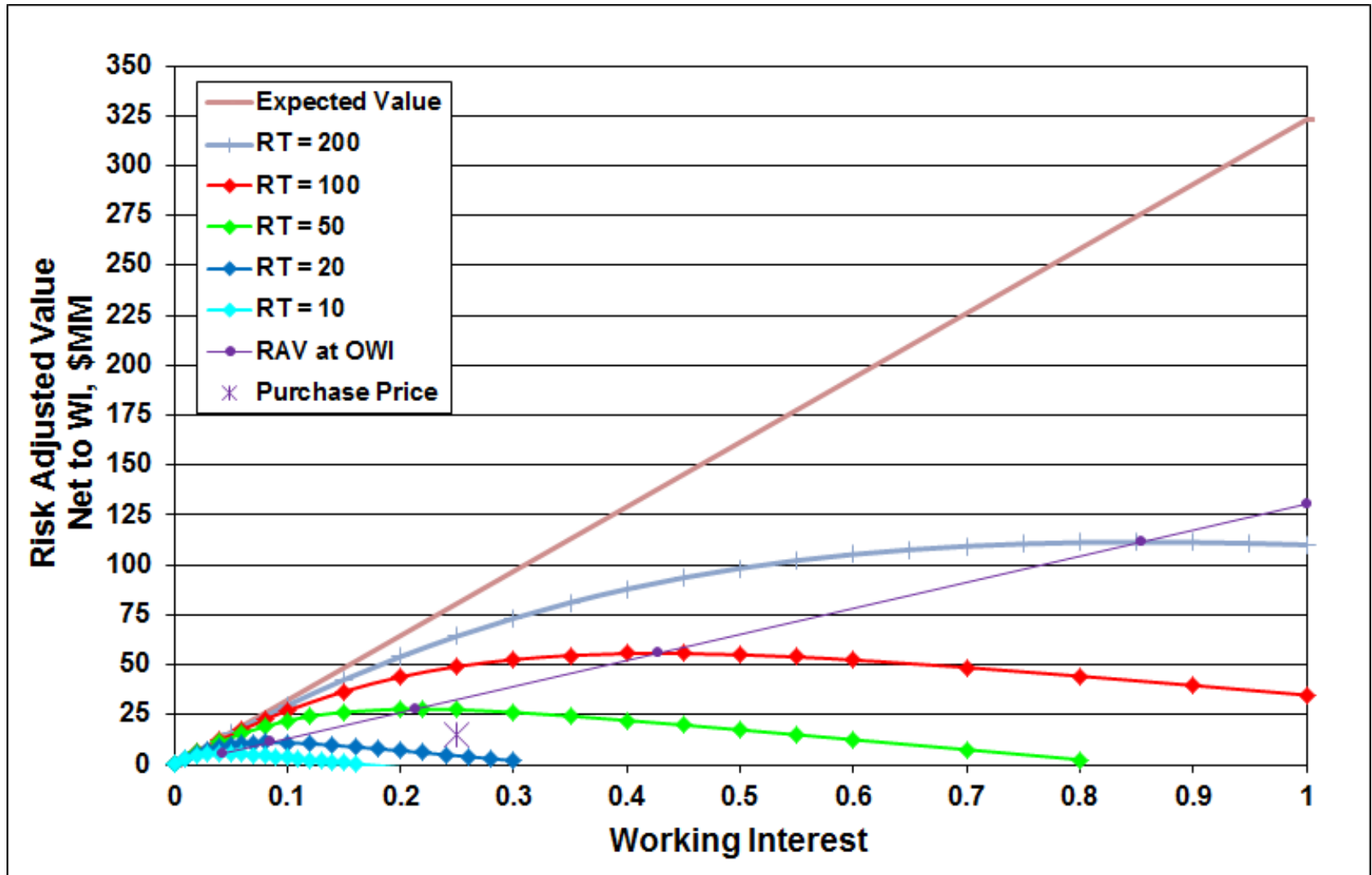
Further Reading

- *Cozzolino, J.M., 1977, A Simplified Utility Framework for the Analysis of Financial Risk, SPE6359, in Proceedings SPE Economics and Evaluation Symposium, Dallas, 21-22 February, 1977*

- *Mackay, J.A., 1995, Utilizing Risk Tolerance to Optimize Working Interest, SPE30043, in Proceedings SPE Economics and Evaluation Symposium, Dallas, 26-28 March, 1995*

- *Lerche, I. and Mackay, J.A., 1999, Economic Risk in Hydrocarbon Exploration, San Diego: Academic Press, 404pp.*

- *Moore, C.R.K., Moyes, C.P., and Patterson, P.D., 2005, The Use of Risk Adjusted Values in Exploration Portfolio Management, SPE 94586, in Proceedings SPE Economics and Evaluation Symposium, Dallas, 3-5 April, 2005*

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