Revenue and Capital Uncertainty in Cash Flow Analysis

Andrew McDonald, SRK Consulting

International Mineral Asset Valuation Conference 2025

Navigating Mineral Asset Valuations in an Uncertain Future

2 to 3 Octobe

Under the Auspices of

Supported By

Agenda

1. Introduction

The Income Approach valuation “requires determination of the present value of future cash flows over the useful life of a Mineral Asset” (SAMVAL, 2016).

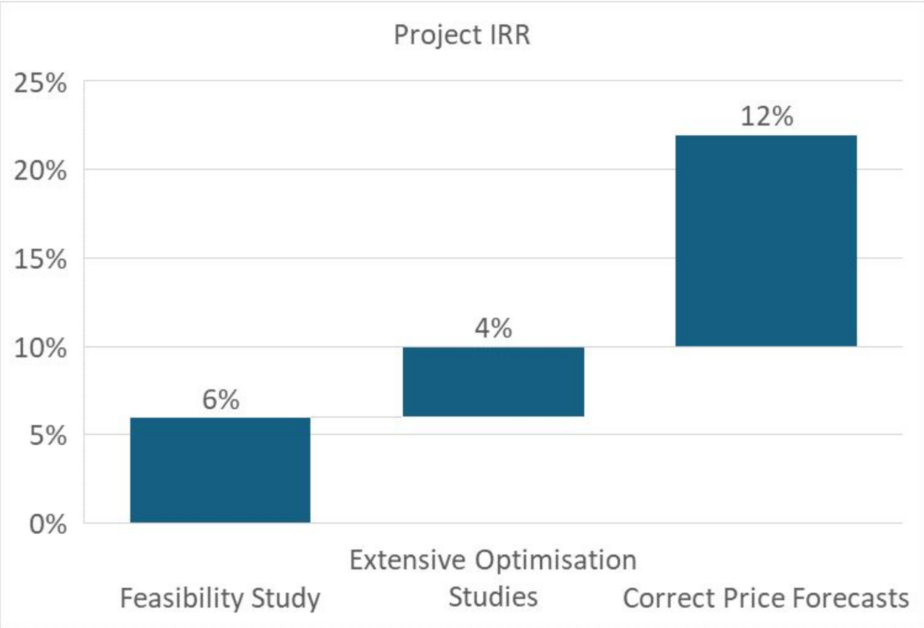
The most common method is the discounted cash flow (DCF) which involves determining the net present value (NPV) of forecast cash flows comprising four money-related sections:

- Revenue (tonnes, grade, recoveries, metal prices, etc),
- Capital costs (project, SIB),
- Operating costs, and
- Legislative costs (ESG aspects, taxes, royalties, etc).

The uncertainties associated with revenue (metal prices) and capital cost components are examined below.

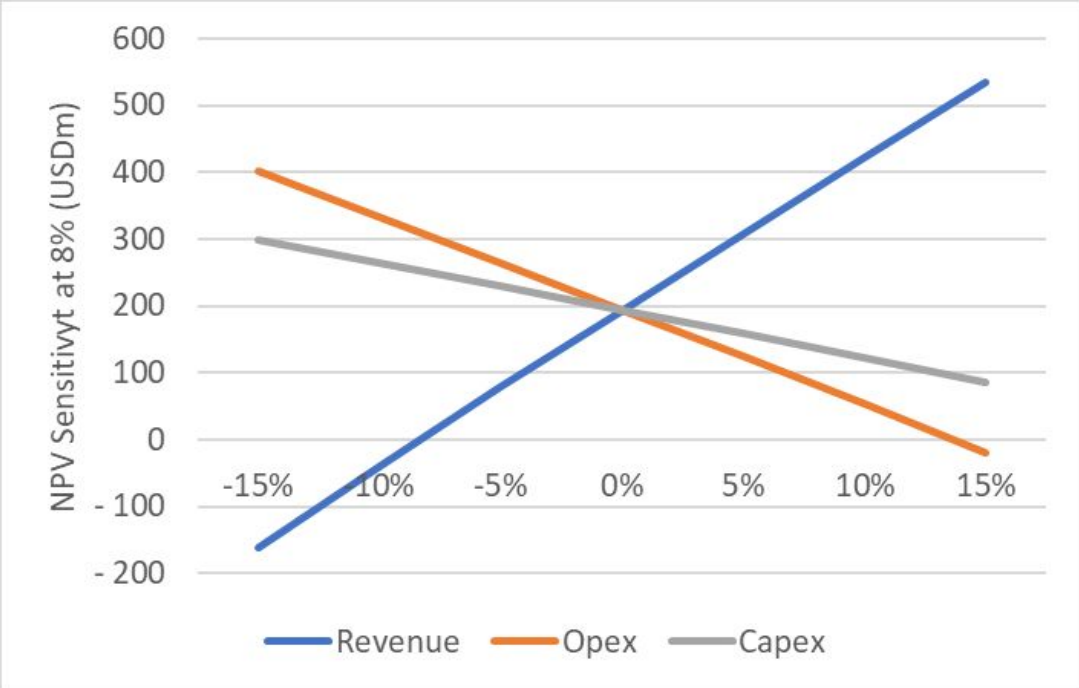
2. Revenue Uncertainty

Companies typically require a hurdle rate of 15% to 20% to decide whether a project is economically viable.



Choice of metal price can play a much more significant role in revenue sensitivity than technical inputs such as plant feed grade or plant recovery

Revenue Uncertainty



NPV @ 8% (USDm)		Revenue Sensitivity						
		-15%	-10%	-5%	0%	5%	10%	15%
Capital Cost Sensitivity	-15%	- 49	70	185	299	412	524	636
	-10%	- 87	33	150	264	378	490	602
	-5%	- 124	- 3	114	229	343	456	568
	0%	- 163	- 40	78	**194**	308	421	534
	5%	- 201	- 78	42	158	273	387	500
	10%	- 240	- 115	5	122	238	352	465
	15%	- 279	- 153	- 32	86	203	317	431

2.1 Uncertainty in Forecast Prices

A consensus price forecast is typically the median, or average, of forecasts from multiple sources; what is seldom considered is the range from highest to lowest within those forecasts.

Forecasts from some sources often span maximum 3 years – LT forecast has low statistical support ("interpolated" values often added to mitigate this)

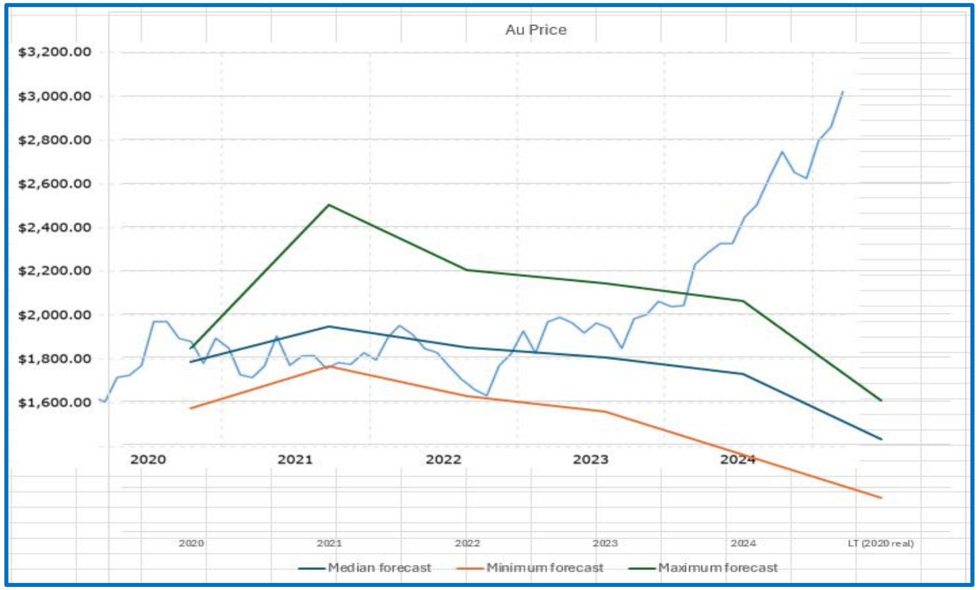
Consider:

- the median, minimum and maximum price forecasts for Cu, Au and Pd in 2020,
- the differences between minimum and maximum values to the median values, expressed as percentages, and
- how the forecasts compared to actual prices from 2020 to March 2025

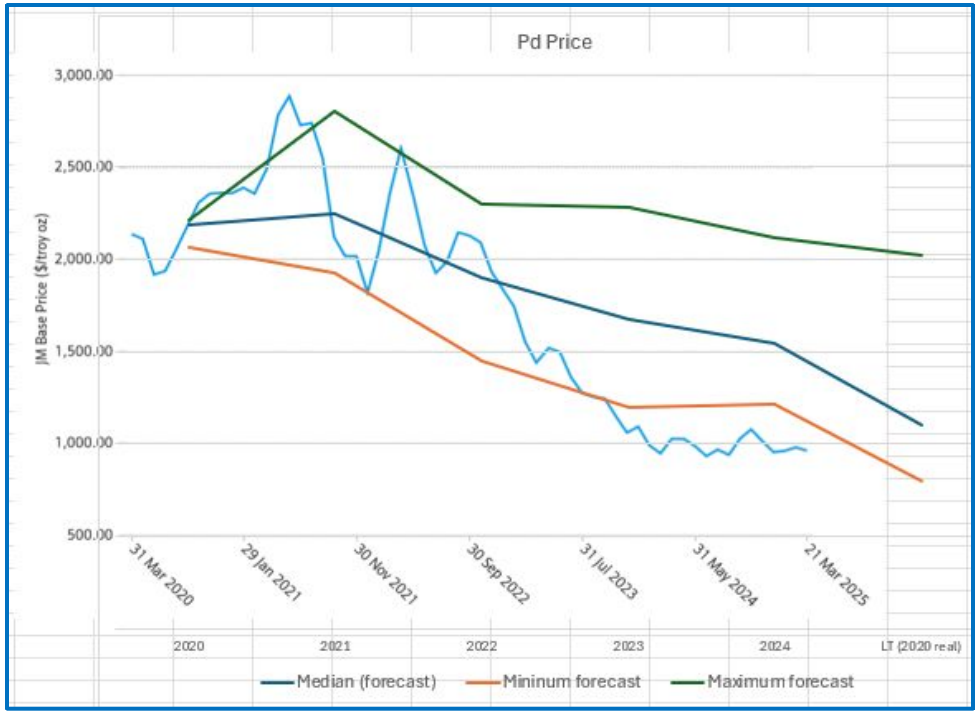
Copper (USD/lb)	2020	2021	2022	2023	2024	LT (2020 real)
Consensus Average	2.77	3.19	3.10	3.11	3.08	3.07
Consensus (Median)	2.77	3.23	3.02	3.00	3.10	3.00
No of forecasts	20	21	18	17	12	14
Minimum	2.72	2.85	2.66	2.53	2.65	2.75
Maximum	2.80	3.50	3.63	3.75	3.45	3.40
Min (relative to Median)	-1.8%	-11.8%	-11.9%	-15.7%	-14.5%	-8.3%
Max (relative to Median)	1.2%	8.4%	20.2%	24.9%	11.3%	13.4%

Uncertainty in Forecast Prices

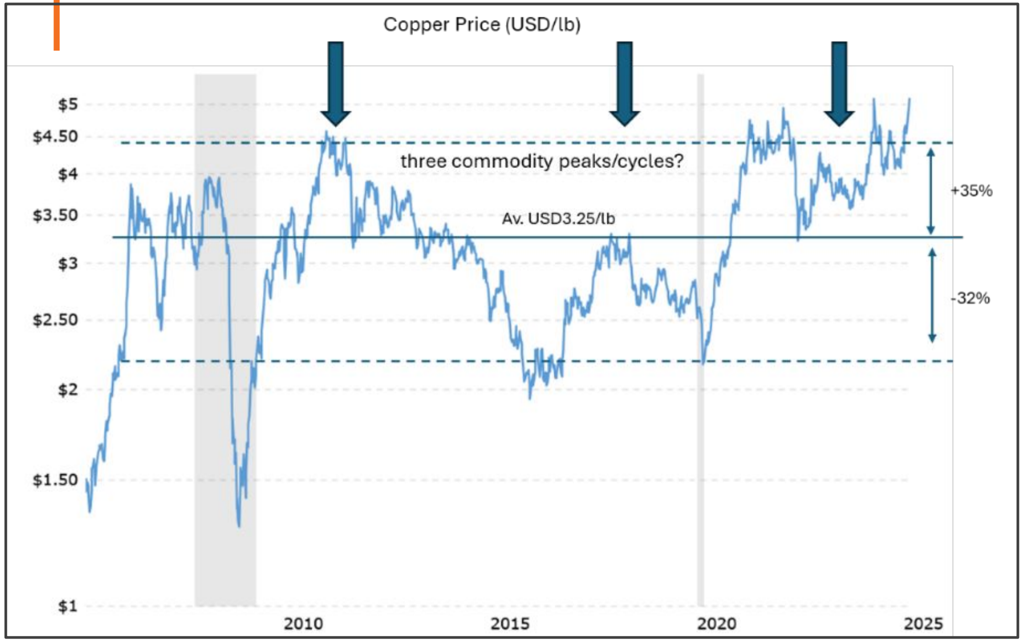
Gold (US$/oz)	2020	2021	2022	2023	2024	LT (2020 real)
Consensus Average	1 773	1 977	1 882	1 788	1 708	1 441
Consensus (Median)	1 777	1 940	1 843	1 800	1 725	1 425
No of forecasts	21	22	20	17	12	12
Minimum	1 563	1 760	1 622	1 550	1 350	1 155
Maximum	1 841	2 500	2 200	2 138	2 060	1 600
Min (relative to Median)	-12.0%	-9.3%	-12.0%	-13.9%	-21.7%	-18.9%
Max (relative to Median)	3.6%	28.9%	19.4%	18.8%	19.4%	12.3%

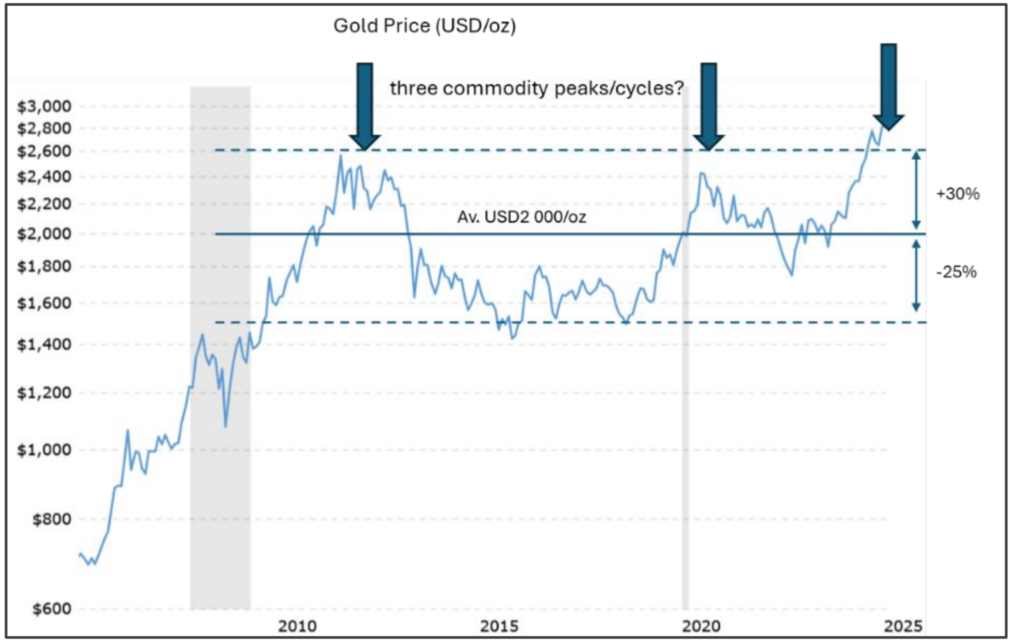


Palladium (US$/ oz)	2020	2021	2022	2023	2024	LT (2020 real)
Consensus Average	2 180	2 248	1 883	1 671	1 598	1 274
Consensus (Median)	2 189	2 245	1 900	1 673	1 549	1 100
No of forecasts	16	16	14	12	8	11
Minimum	2 064	1 925	1 450	1 200	1 219	800
Maximum	2 215	2 800	2 300	2 281	2 116	2 025
Min (relative to Median)	-5.7%	-14.3%	-23.7%	-28.3%	-21.3%	-27.3%
Max (relative to Median)	1.2%	24.7%	21.0%	36.4%	36.6%	84.1%

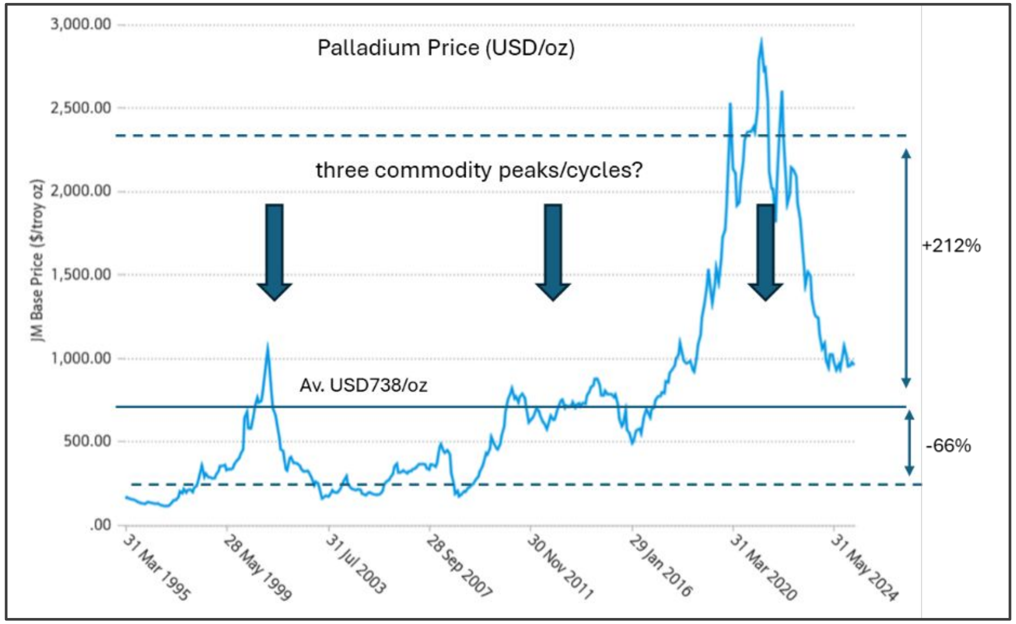


2.2 Sensitivity Analysis across multiple cycles (cf. Somerville, 2015)





Item	Range below/above Average
Copper (USD/lb)	
Min (relative to average)	-32%
Max (relative to average)	+35%
Gold (USD/oz)	
Min (relative to average)	-25%
Max (relative to average)	+30%
Palladium (USD/ oz)	
Min (relative to average)	-66%
Max (relative to average)	+212%



Sensitivity ranges for metal prices

Item	Range above/below Average	
	Uncertainty in Forecast Prices	Sensitivity Analysis across multiple cycles
Copper (USD/lb)		
Min (relative to average)	-16%	-32%
Max (relative to average)	+25%	+35%
Gold (USD/oz)		
Min (relative to average)	-22%	-25%
Max (relative to average)	+29%	+30%
Palladium (USD/oz)		
Min (relative to average)	-28%	-66%
Max (relative to average)	+84%	+212%

Conclusions:

- expanded sensitivity ranges on metal prices should be used (not just -15% to +15%).
- the sensitivity range may be commodity specific, i.e. suggests a standard range cannot be used for all commodities.
- an expanded sensitivity range of -30% to +40% is used for illustrative purposes.

2.3 Observable Inputs

IFRS 13 (2011) requires that an entity shall maximise the use of relevant observable inputs and minimise the use of unobservable inputs to meet the objective of a fair value measurement.

American Manganese Inc. agreed to use a three-year trailing average price in evaluating the economic feasibility of its Artillery Peak Project due to concerns raised by the British Columbia Securities Commission (Reugh, 2012).

This provided a more conservative price forecast in a rising market relative to the expected case used in the study, resulting in a negative NPV and withdrawal of a Mineral Reserve announcement.

The earlier spider diagram showed a NPV at 8% of USD194m based on three-year trailing average prices.

Spot prices USD448m
Consensus forecast -USD56m

Essential to include spot and 3-year trailing average prices in a cash flow evaluation, to check price sensitivity.

3. Capital Cost Uncertainty

Required accuracy (confidence) limits of the capital cost estimate get tighter as the project advances (e.g. SK-1300):

- Concept phase ±50%
- Prefeasibility Study ±25%
- Feasibility study ±15%.

EY's survey showed key risk for 2025 is capital (Mitchell, 2024).
Miners must:

- manage capital discipline,
- meet higher stakeholder expectations, and
- manage resource nationalism.

 Latter may require JVs with local companies, potentially impacting capital efficiency.

3.1 Capital Cost overruns

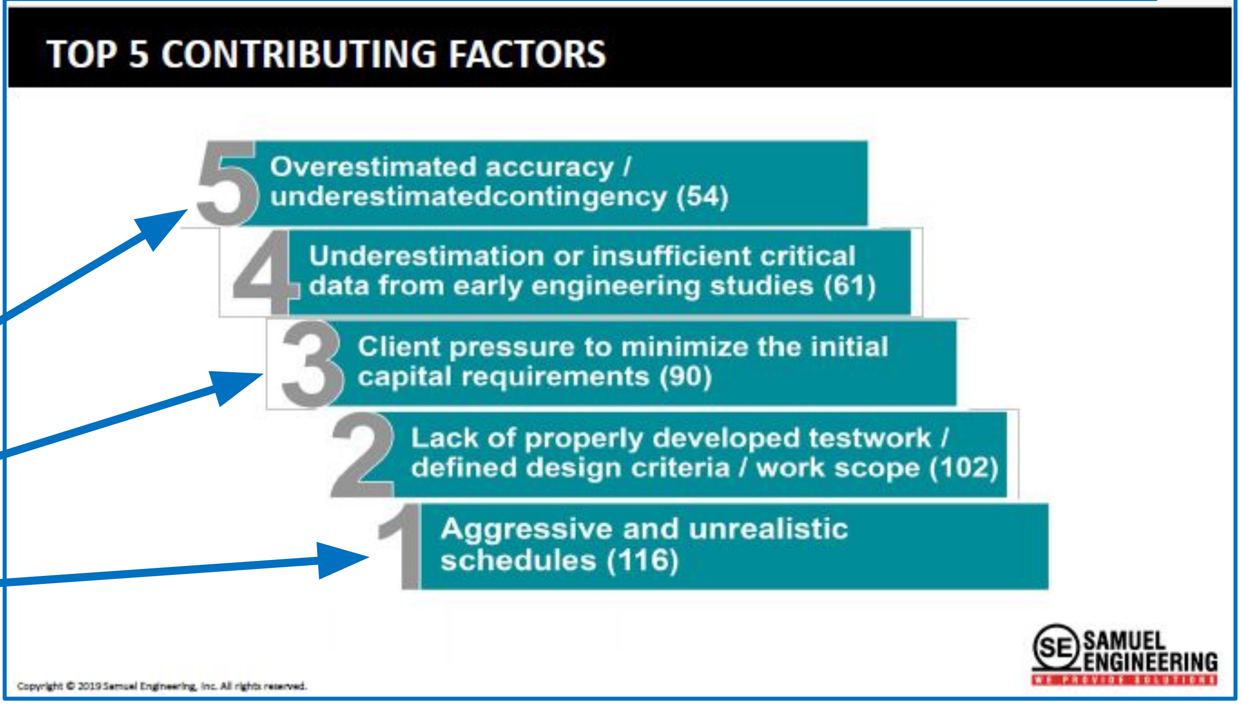
Completed cost of many mining projects:

- Exceed feasibility study budget by between 50% and >100%, vs a capital budget nominally ±15%.

Class action by shareholders in 2000s, where capital cost for Nova Gold's project had increased by 131%.
Terhune (2020) argued such cost overrun was due to:

- Poor engineering assumptions
- Lack of understanding of key risks
- Aggressive timelines
- Bias.

Kuestermeyer (2019) – top five contributing factors to capital cost overruns:



Is this a case of too much optimism in feasibility studies to ensure a project can be financed?

"Give us money, we want to build this project, we are going to probably come in 50% over and our schedule is probably going to be 70% longer than we told you .." (Varis, 2025) [Critical Minerals Assoc' conference Dec'24]

Capital Cost overruns

Cost and scheduling challenges affected 83% of major projects since COVID-19 (Mencarini et al, 2024):

- Cost overruns at least 79% higher than initial budgets
- Schedule delays averaged 52% higher than initial time frame
- Avoiding cost overruns & schedule delays:
  - 10% of projects (>USD1bn)
  - 20% of projects (<USD1bn)

"BHP faces $1.7bn cost blowout at Canada project"

+30% vs $5.7bn budget,
1st production 9 months later,
phase 2 delayed by 2 years
(miningmx 18 July 2025)

Studies cited by MacKenzie and Cusworth (2016):

- Pre 2002 average cost overrun 25% - 26%
- Post 2002 only 25% delivered within time and budget
- Recent (up to 2015) 69% of projects had average cost overrun of 62%
- 2006 to 2013 vast majority significant cost overruns
  average schedule slip 20% (but up to 80%)

Costs of developing Karowe underground project had "spiralled out of control", with completion 2 years late (Mackay, 2025).

Construction cost for Horizonte Minerals' nickel project would be nearly double what it had forecast (Farchy, 2025).

Sensitivity Range

for capital cost overruns should be

-10% to +60%

3.2 Project Delays

Earlier saw that schedule delays could be:

- 70% longer Varis (2025)
- 52% higher Mencarini et al (2024)
- 20% (but up to 80%) MacKenzie and Cusworth (2016)
- 2 years late McKay (2025)

A 12-month delay on a 2-year construction period (50% delay) is simulated as follows:

Aspect	Proportion of Project Budget	Simulated Impact on Capital Budget
EPCM costs (assume 2-year build)	17%-20% of direct costs	+10%
Owners' costs, preproduction costs	5%-10% of direct costs	+5%
Escalation	Usually excluded	+5% (in US Dollar terms)
Opportunity cost from delayed production	Not applicable	+5%

Sensitivity Range

for capital cost overruns

with schedule delays (+25% on capital cost)

should be

-10% to +85%

3.3 Confidence vs Capital Contingency

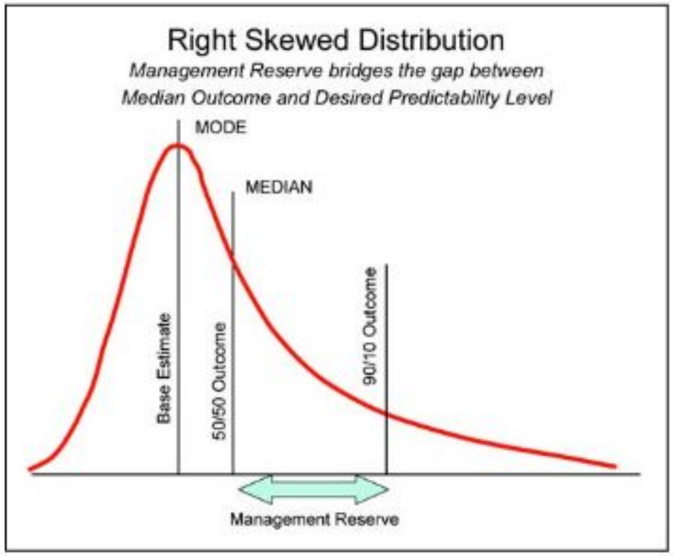
Albrecht (2015):

- Low Contingency ≠ High Accuracy (confidence)
- High Contingency ≠ Low Accuracy (confidence)

Contingency – a measure of how well a project is defined
Accuracy – a measure of how confident have defined the right project.

Required contingency for capital cost estimates (e.g. SK-1300):

- Concept phase ≤25%
- Prefeasibility Study ≤15%
- Feasibility study ≤10%.



Set of possible cost outcomes is not normally distributed (Lawrence, 2007)

- Contingency – gap between base estimate (the mode) and 50/50 outcome point (median)
- Management reserve – includes design allowances, also to cater for probability of a project overrun.

Presentation of a Capital Cost Estimate:

- With reference to a level of desired probability, e.g. ±10% estimate within 80% probability range (Lawrence, 2007), OR
- Cost ranges – minimum possible to maximum possible (Emerald, 2016)

3.3 Confidence vs Contingency

A Capital Cost Estimate to the nearest cent, e.g. USD500 258 175.93,
does not increase one's confidence in the estimate.

This level of significant figures is meaningless.

At feasibility study stage, the designs are generally not of sufficient detail to allow construction to start, quantities extracted from the designs remain ***estimates***.

Perhaps capital cost estimates should be rounded to appropriate significant figures to reflect the uncertainty in the estimate, like reporting of mineral resource tonnage estimates.

Inclusion of a contingency ≤10% at feasibility study does not adequately cater for the cost overruns and schedule delays seen in practice.

4. Addressing Revenue/Capital Uncertainties

A valuation based on a cash flow model is not a fact (Aronsohn, 2020):

- It is an estimate based on a suite of assumptions
- The cash flow inputs are current expectations of future performance, therefore uncertain

NPV sensitivity of cash flows to changes in revenue, capital and operating cost typically in the -15% to +15% range for a feasibility study is:

- Not sufficient to cover price volatility
- Not sufficient to cover range of outcomes in project capital costs
- Not sufficient to cover project delays
- Contingencies of <10% do not cater for capital cost overruns and schedule delays.

We saw earlier the benefit of a twin-sensitivity table where the effect of combined changes in revenue and capital cost in the range -15% / +15% can be determined.
To cater for the identified uncertainties, expand the twin-sensitivity table ranges to:

- Revenue -30% to +40%
- Capital -10% to +100%,
  - Cost overruns +60%
  - Project delays +25%
  - Contingencies +15%

Addressing Revenue/Capital Uncertainties

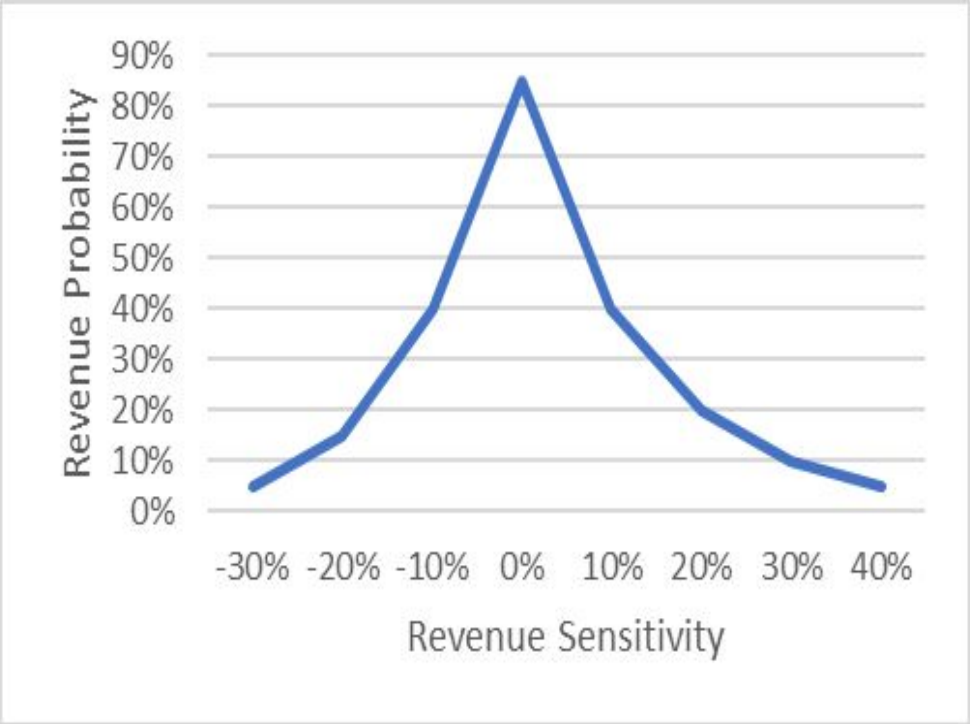
NPV at 8% (USDm)		Revenue Sensitivity							
Basket Price (USD/oz)		1 217	1 390	1 553 (Consen)	1 738 (3-yr Av.)	1 813 (Spot)	2 086	2 259	2 433
		-30%	-20%	-10.7%	0%	+11.2%	+20%	+30%	+40%
Capital Cost Sensitivity	-10%	-504	-211	18	264	517	713	935	1 156
	0%	-596	-290	-56	194	448	646	869	1 090
	+10%	-687	-371	-131	122	379	578	801	1 023
	+20%	-778	-453	-208	50	309	509	734	957
	+30%	-870	-537	-285	-23	238	440	666	889
	+40%	-961	-622	-364	-98	167	370	597	821
	+50%	-1 052	-710	-443	-173	95	300	528	753
	+60%	-1 144	-801	-524	-249	22	228	458	684
	+70%	-1 235	-893	-606	-326	-52	156	387	615
	+80%	-1 326	-984	-688	-404	-127	84	317	546
	+90%	-1 418	-1 075	-772	-483	-202	11	245	475
	+100%	-1 509	-1 167	-856	-562	-278	-63	173	405

The extreme range of –USD1 509m to USD1 156m is too wide, meaningless in terms of VALMIN (2015).

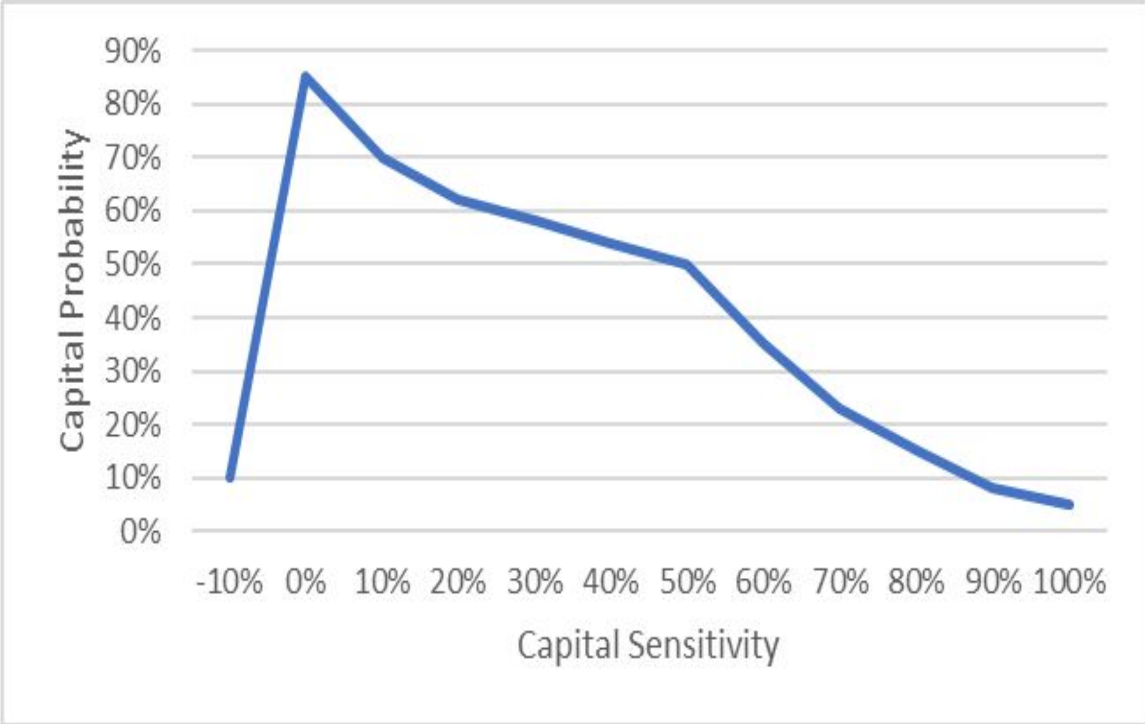
Yet these are probable outcomes with essentially equal chance of occurrence.

Addressing Revenue/Capital Uncertainties

Review of revenue uncertainty - a slightly-skewed normal distribution of probabilities, with -30% to +40%



Review of capital uncertainty - a skewed distribution of probabilities from -10% to +100%, with an inflexion point at 50%



Addressing Revenue/Capital Uncertainties

Weighted NPV Sensitivity at 8% (USDm)				Revenue Sensitivity							
				-30%	-20%	-10.7%	0%	+11.2%	+20%	+30%	+40%
				Revenue Probability of Occurrence							
				5%	15%	40%	85%	40%	20%	10%	5%
Capital Cost Sensitivity	-10%	**Capital Cost Probability of Occurrence**	10%	-3	-3	1	22	21	14	9	6
	0%		85%	-25	-37	-19	140	152	110	74	46
	+10%		70%	-24	-39	-37	73	106	81	56	36
	+20%		62%	-24	-42	-51	26	77	63	45	30
	+30%		58%	-25	-47	-66	-12	55	51	39	26
	+40%		54%	-26	-50	-79	-45	36	40	32	22
	+50%		50%	-26	-53	-89	-74	19	30	26	19
	+60%		35%	-20	-42	-73	-74	3	16	16	12
	+70%		23%	-14	-31	-56	-64	-5	7	9	7
	+80%		15%	-10	-22	-41	-52	-8	3	5	4
	+90%		8%	-6	-13	-25	-33	-6	0	2	2
	+100%		5%	-4	-9	-17	-24	-6	-1	1	1

Sum of all probability-weighted entries = USD122m = most-probable value (reasonably aligned to 85%/85% entry)

Range: –USD89m to USD152m.

5. Conclusions

Importance of including comparative financial results using observable inputs (spot & 3-year trailing average) is emphasised.

The maximum and minimum range limits for assessing revenue sensitivity should be obtained from:

- The percentage differences between the maximum/minimum forecasts and the median forecast

  In conjunction with
- The price volatility over several commodity cycles as percentages, per Somerville (2015).

These range limits are likely to be commodity specific, but wider than ±15%.

The range limits for capital cost sensitivity should be widened to cater for the probability of:

- Cost overruns,
- Project delays, and
- Contingency shortfalls.

Recommend the capital sensitivity range should be -10% to +100% (even for a FS).

"*Competent Persons responsible for preparing technical reports, should be extremely conservative with the ranges of precision and contingencies contemplated in each phase*" (Nieto et al, 2024)

Conclusions

Any valuation report should provide a clear understanding of the valuation with minimum complication (Aronsohn, 2020).

Uncertainties in metal price forecasts and probability of capital cost overruns are significant

could "*expose the commissioning entity or a third party relying on the valuation to significant risk or loss*" if not fully disclosed (Aronsohn, 2020).

Aronsohn (2020) concluded regarding uncertainty analysis:

- Any test .. should address the impact of reasonable and likely alternative assumptions;
- Provide information about the variability of the value at the effective date of the valuation;
- The interdependence between significant inputs should be considered.

The twin-sensitivity plot with expanded sensitivity ranges and evaluated on a probability-weighted basis as presented here satisfies Aronsohn's conclusions.

Thank You

Revenue and Capital Uncertainty in Cash Flow Analysis

Presented by:

Andrew McDonald

SRK House
265 Oxford Road, Illovo
Johannesburg 2196

Email: amacdonald@srk.co.za

srk consulting