# The RADR Paradox

## Discount Rates, Risk, & Long Life Projects

***Risk Adjusted Discount Rates***

***Risk Adjusted Net Present Values***

***Risk Adjusted Cash Flows***



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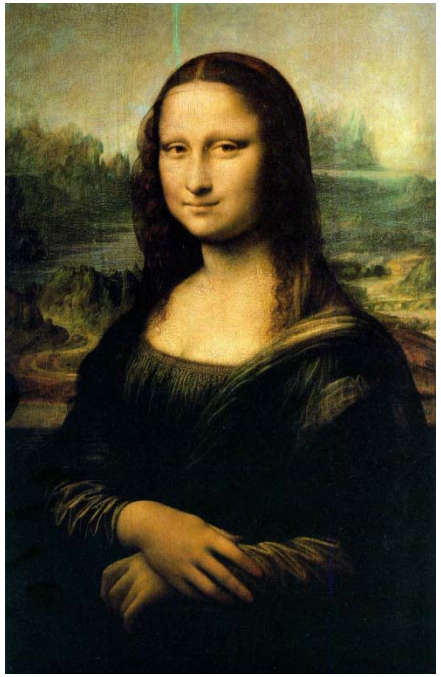
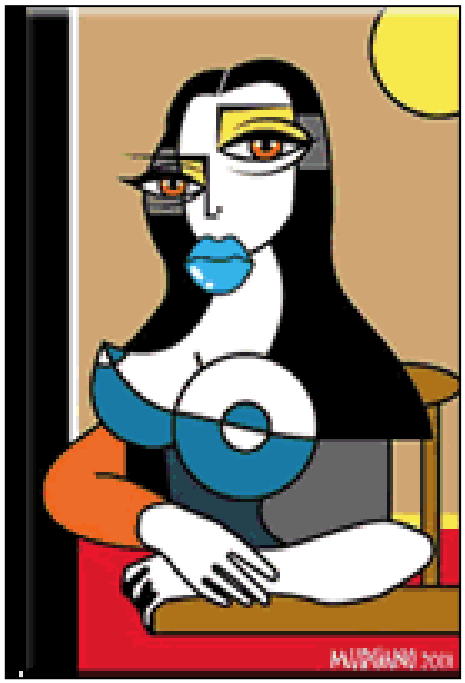
He is a mining engineer with over 35 years' experience in project economic evaluations including scoping and optimization studies, pre-feasibility and feasibility studies, risk assessment, and due diligence and has published a number of papers on these topics. He is on the executive of MES and CIM Toronto.

Larry teaches Mineral Economics as an adjunct professor at the University of Toronto, the Pontificia Universidad Catolica de Valparaiso in Chile and Schulich Business School at York University.

# Oldies But Goodies
# Mona Lisa Examples

- Some of the illustrations are older, but classic
- The new versions are not always as good.





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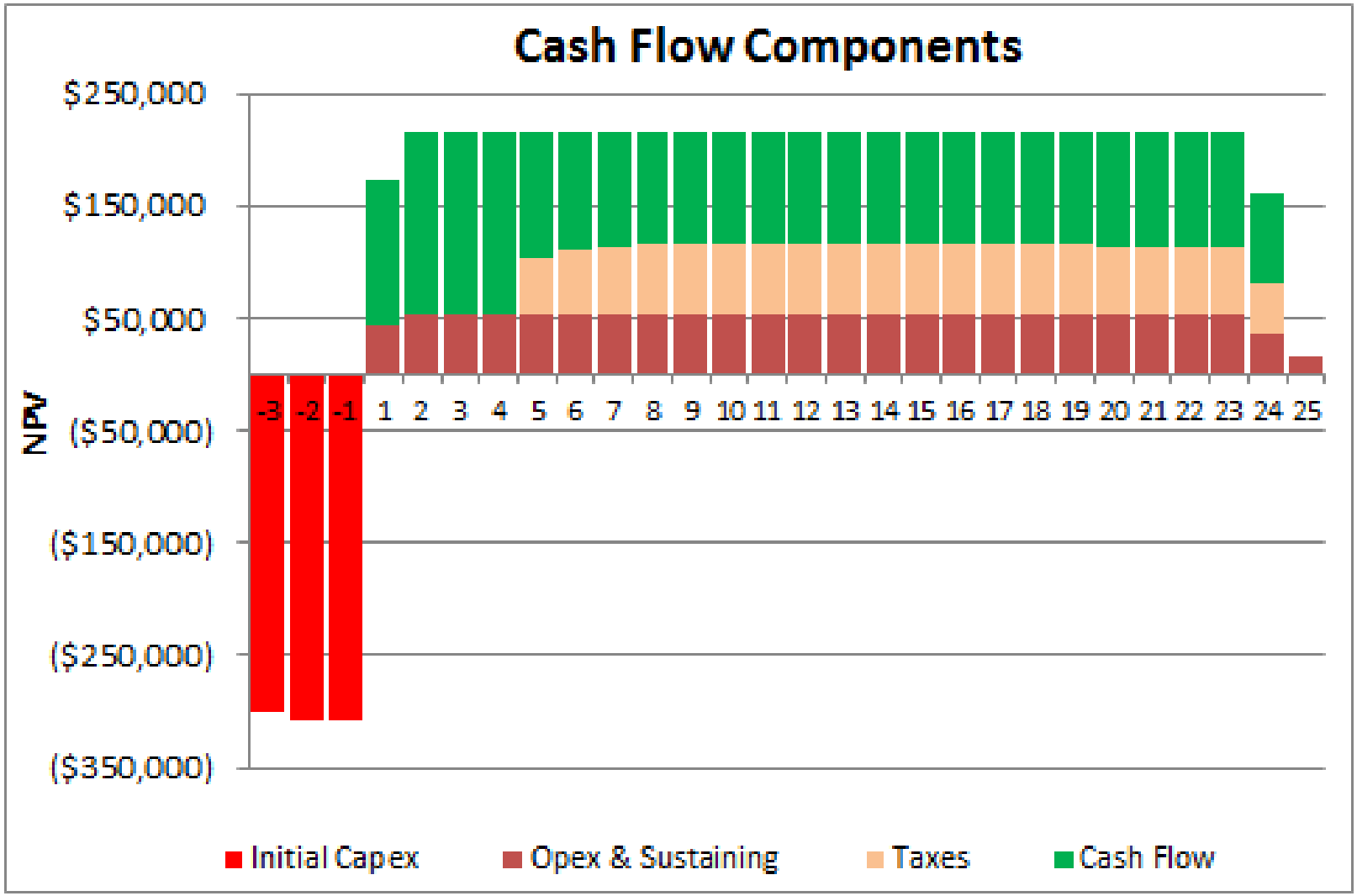
Yogi Berra quotes: It gets late early out there. Ninety percent of this game is half-mental. Nobody goes there anymore. It's too crowded. We made too many wrong mistakes. When you come to a fork in the road, take it. It ain't over 'till it's over. You can observe a lot by watching. It's déjà vu all over again. If you don't know where you're going, you might not get there. **The future is not what it used to be.**

# Cash Flow Components
# Production & Revenue



# Project Cash Flow
# Discounted Cash Flow (DCF) Metrics

| Project Cash Flow | TOTAL | -3 | -2 | -1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Concentrate Net Smelter Return | 3,647,412 | 0 | 0 | 0 | 123,904 | 154,880 | 154,880 | 154,880 | 154,880 | 154,880 | 154,880 | 154,880 |
| Dore Net Revenue | 1,492,375 | 0 | 0 | 0 | 50,696 | 63,371 | 63,371 | 63,371 | 63,371 | 63,371 | 63,371 | 63,371 |
| Revenue | 5,139,788 | 0 | 0 | 0 | 174,600 | 218,250 | 218,250 | 218,250 | 218,250 | 218,250 | 218,250 | 218,250 |
| Operating Costs | -1,181,760 | 0 | 0 | 0 | -40,400 | -50,380 | -50,380 | -50,380 | -50,380 | -50,380 | -50,380 | -50,380 |
| NSR Royalty | -77,097 | 0 | 0 | 0 | -2,619 | -3,274 | -3,274 | -3,274 | -3,274 | -3,274 | -3,274 | -3,274 |
| Operating Cash Flow | 3,880,931 | 0 | 0 | 0 | 131,581 | 164,596 | 164,596 | 164,596 | 164,596 | 164,596 | 164,596 | 164,596 |
| Capital - Initial | -917,900 | -300,967 | -308,467 | -308,467 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Capital - Sustaining | -79,200 | 0 | 0 | 0 | -3,300 | -3,300 | -3,300 | -3,300 | -3,300 | -3,300 | -3,300 | -3,300 |
| Capital - Decommissioning | -17,000 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Change in Working Capital | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cash Flow Before Taxes | 2,866,831 | -300,967 | -308,467 | -308,467 | 128,281 | 161,296 | 161,296 | 161,296 | 161,296 | 161,296 | 161,296 | 161,296 |
| Income & Mining Tax | -1,190,248 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -49,824 | -58,054 | -60,007 | -60,952 |
| Total Cash Flow | 1,676,582 | -300,967 | -308,467 | -308,467 | 128,281 | 161,296 | 161,296 | 161,296 | 111,472 | 103,242 | 101,289 | 100,344 |
| Accum | | -300,967 | -609,433 | -917,900 | -789,619 | -628,323 | -467,026 | -305,730 | -194,258 | -91,016 | 10,273 | 110,618 |

| DCF Metrics | |
|---|---|
| IRR | 10.7% |
| Payback | 6.9 years |
| NPV @ 0.0% | 1,676,582 |
| NPV @ 5.0% | 521,446 |
| NPV @ 10.0% | 42,866 |
| NPV @ 10.7% | 0 |
| NPV @ 15.0% | -174,349 |
| NPV @ 20.0% | -278,667 |

**Evaluation Metrics Cash Flow & DCF:**

- Total Cash Flow
- IRR
- Payback Period
- NPV

# Net Present Value
# Equations and Exponents





| Years & Counters | Project Year | | -3 | -2 | -1 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|---|
| | Calendar Year | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| | Exponent Year | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Discount Factors | 0.0% | | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| Discount Factors | 2.5% | | 0.9756 | 0.9518 | 0.9286 | 0.9060 | 0.8839 | 0.8623 | 0.8413 |
| Discount Factors | 5.0% | | 0.9524 | 0.9070 | 0.8638 | 0.8227 | 0.7835 | 0.7462 | 0.7107 |
| Discount Factors | 10.0% | | 0.9091 | 0.8264 | 0.7513 | 0.6830 | 0.6209 | 0.5645 | 0.5132 |
| Discount Factors | 15.0% | | 0.8696 | 0.7561 | 0.6575 | 0.5718 | 0.4972 | 0.4323 | 0.3759 |
| **Project Cash Flow** | | 1,676,582 | -300,967 | -308,467 | -308,467 | 128,281 | 161,296 | 161,296 | 161,296 |
| Discounted Cash Flow | 0.0% | 1,676,582 | -300,967 | -308,467 | -308,467 | 128,281 | 161,296 | 161,296 | 161,296 |
| Discounted Cash Flow | 2.5% | 967,230 | -293,626 | -293,603 | -286,442 | 116,216 | 142,562 | 139,085 | 135,693 |
| Discounted Cash Flow | 5.0% | 521,446 | -286,635 | -279,788 | -266,465 | 105,537 | 126,380 | 120,362 | 114,630 |
| Discounted Cash Flow | 10.0% | 42,866 | -273,606 | -254,931 | -231,756 | 87,618 | 100,152 | 91,048 | 82,770 |
| Discounted Cash Flow | 15.0% | -174,349 | -261,710 | -233,245 | -202,822 | 73,345 | 80,193 | 69,733 | 60,637 |

Reference Date: t=0
Start of year -3
Count the exponent "n" from a Project Reference Date.
If project years are -2,-1,1,2,3, etc DO NOT use the project year values as the exponents.

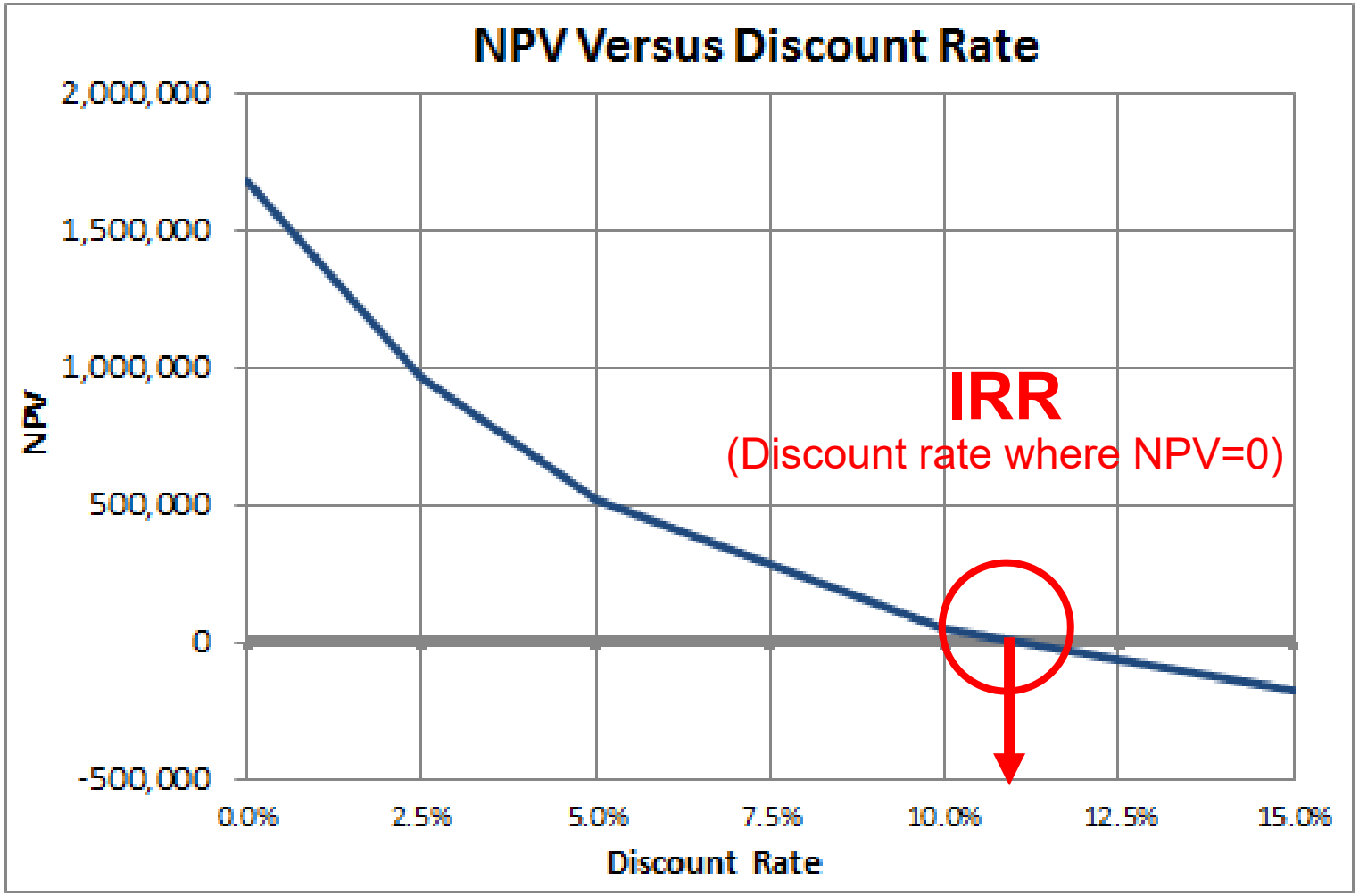
**NPV Factor = $1/(1+i)^n$** $.7835 = 1/(1.05)^5$

End-of-Year Convention

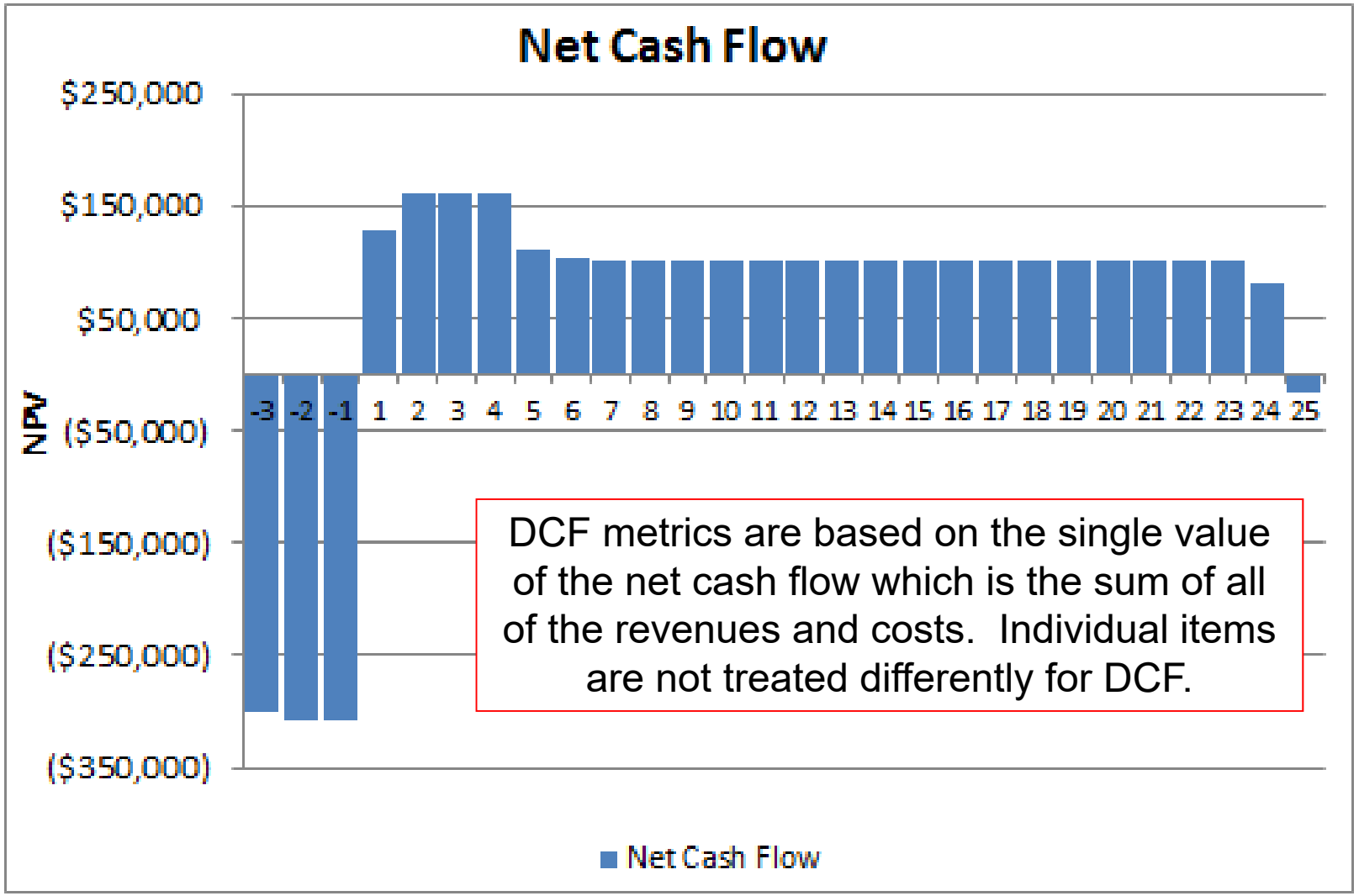
| Cash Flow | Factor | NPV |
|---|---|---|
| 161,296 | 0.7835 | 126,380 |

# Project Cash Flow
# NPV vs Discount Rate & IRR



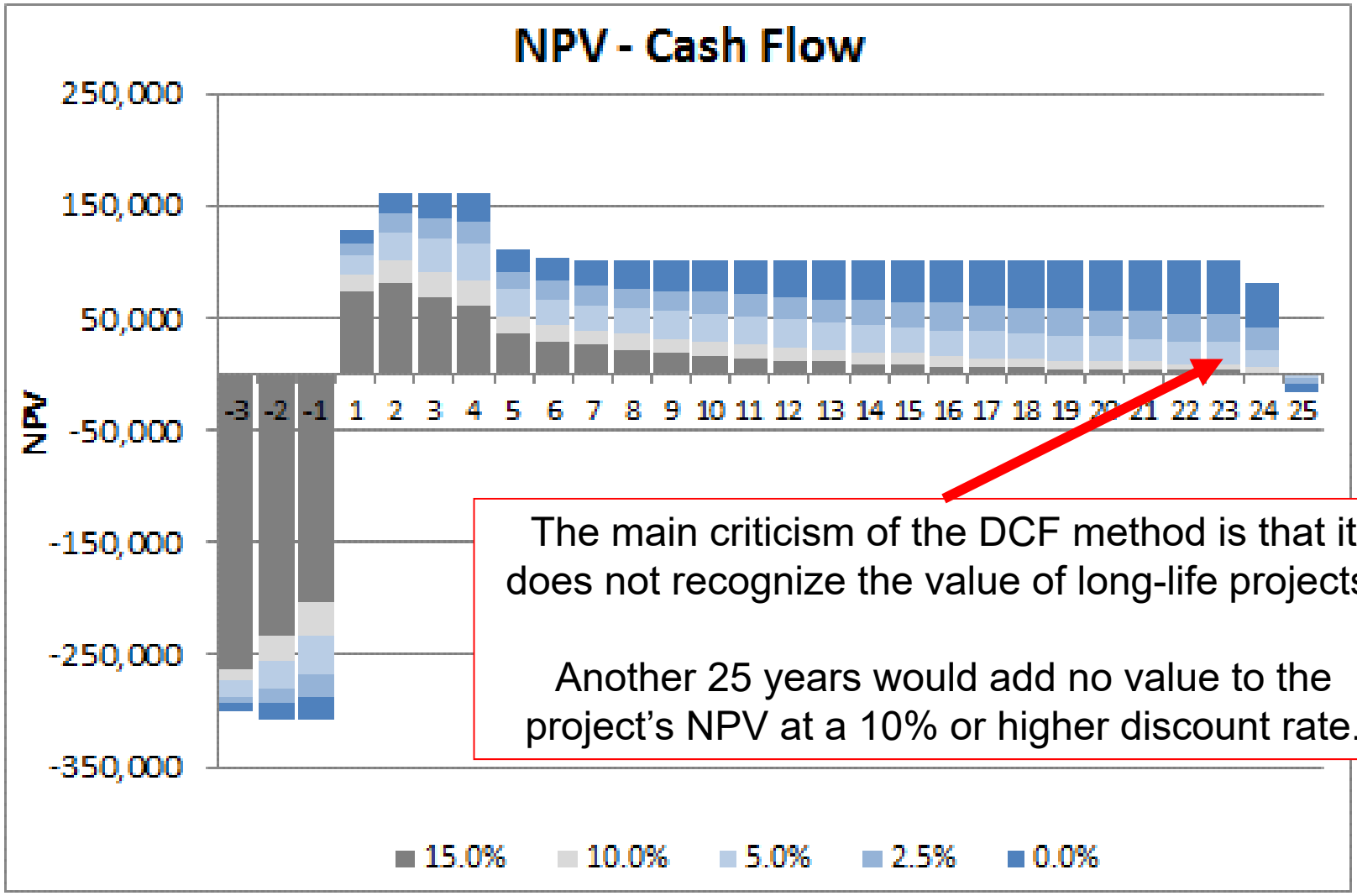


# Cash Flow Components
# Net Cash Flow



# The Problem With DCF
# Impact Of Discount Rate On Net Present Value



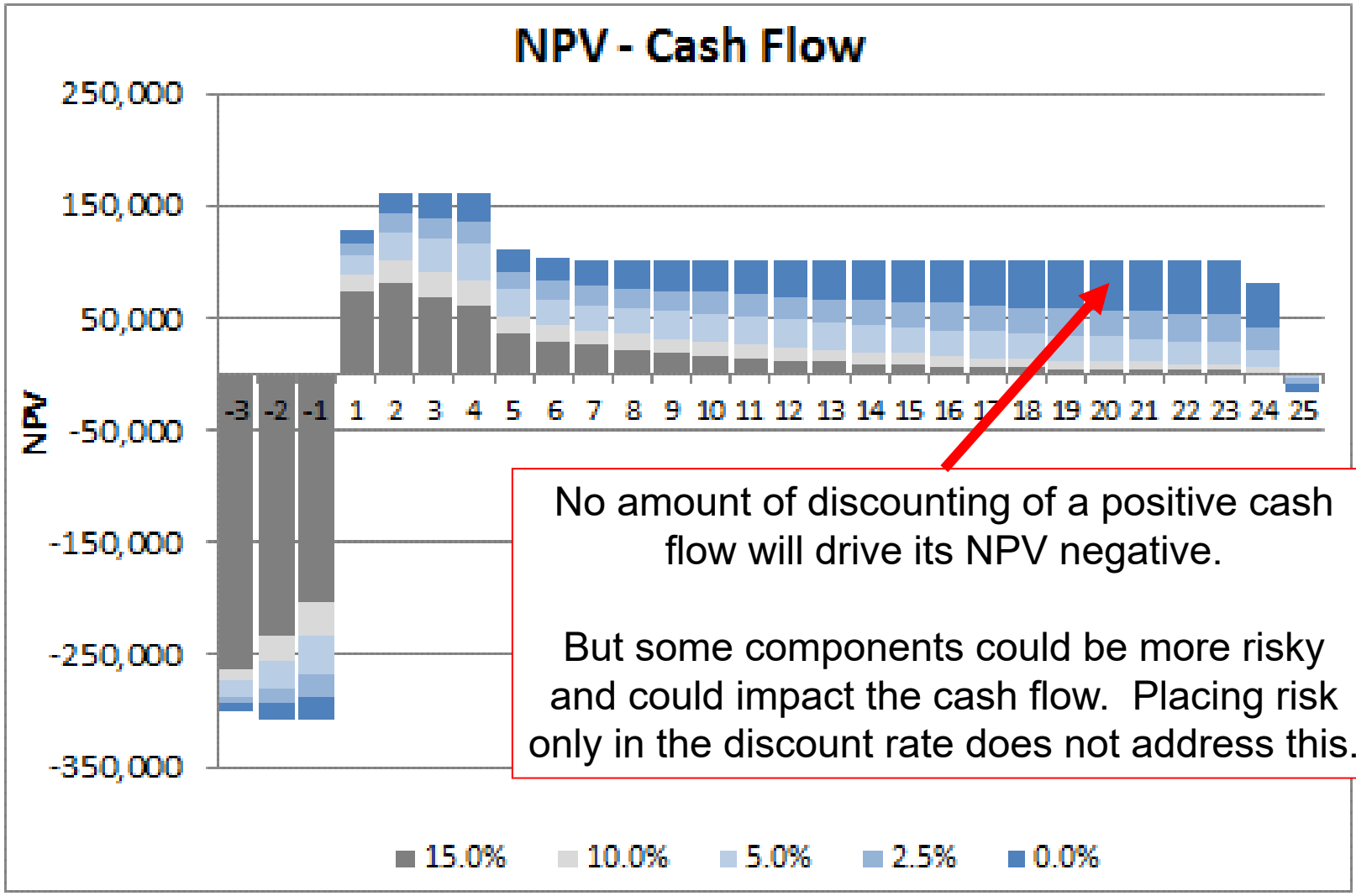



The main criticism of the DCF method is that it does not recognize the value of long-life projects.

Another 25 years would add no value to the project's NPV at a 10% or higher discount rate.

# The Problem With DCF
## Impact Of Discount Rate On Net Present Value






No amount of discounting of a positive cash flow will drive its NPV negative.

But some components could be more risky and could impact the cash flow. Placing risk only in the discount rate does not address this.

# The Problem With DCF
# Does Not Recognize Value of Long Life Projects



- The Discounted Cash Flow (DCF) method of valuations is universally used and accepted.
- The main criticism of the method is that it does not recognize the value of long life projects.
- As discount rates increase, the present value of cash flows in later years are small. Doubling or even tripling the project's life will add almost no value to total project NPV.

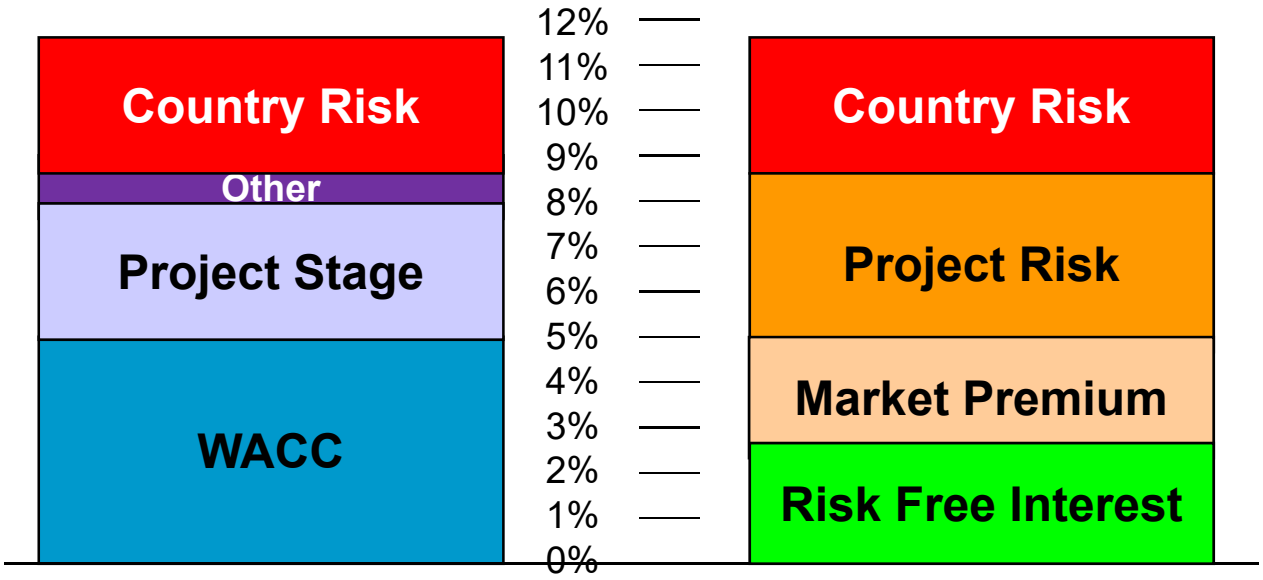
- A non-mining example:
- In the evaluation of a pulp and paper project it was determined that it was not possible to justify planting the trees as they took too long to grow and so had no appreciable NPV. The mill had to purchase wood to feed the plant.



# Selecting The Discount Rate

# Discount Rates - RADR
# Risk Adjusted Discount Rate Build-Up

- The Risk Adjusted Discount Rate is often build up starting with the corporate Weighted Average Cost of Capital (WACC) and adding increments of risk.
- This can also be expressed in terms of the real risk free interest rate (the basic time value of money) plus market Risk Premium plus Project Risk plus Country Risk.



# Discount Rates - RADR
# Risk Adjusted Discount Rate Based on WACC

| | | |
|---|---|---|
| + | WACC Expected return for company (real) (1,2) | X% |
| + | Adjust for metal | X% |
| + | Adjust for stage of project development | X% |
| + | Adjust for technology risk (3) | X% |
| + | Adjust for remoteness (3) | X% |
| + | Adjust for country risk | X% |
| = | Risk adjusted discount rate for project (real) (2) | X% |

Notes:

1. Using WACC assumes the project is funded from general corporate funds.
2. If the cash flow is in real terms, the discount rate must be real. If the cash flow is in nominal terms, the discount rate must be nominal.
3. Not all practitioners chose to address technology risks and remoteness risks in the discount rate.





# Discount Rates – RADR
# Risk Adjusting for Metals

- Gold companies typically have a low WACC
  - Typically around 4%-5% real
- Base Metal companies typically have a slightly higher WACC
  - Typically around 7%-8% real
- A gold company with a base metal project or operation will typically increase the RADR for these metals:
  - Copper in a Gold company:  2%
  - Base Metals in a Gold company: 3%

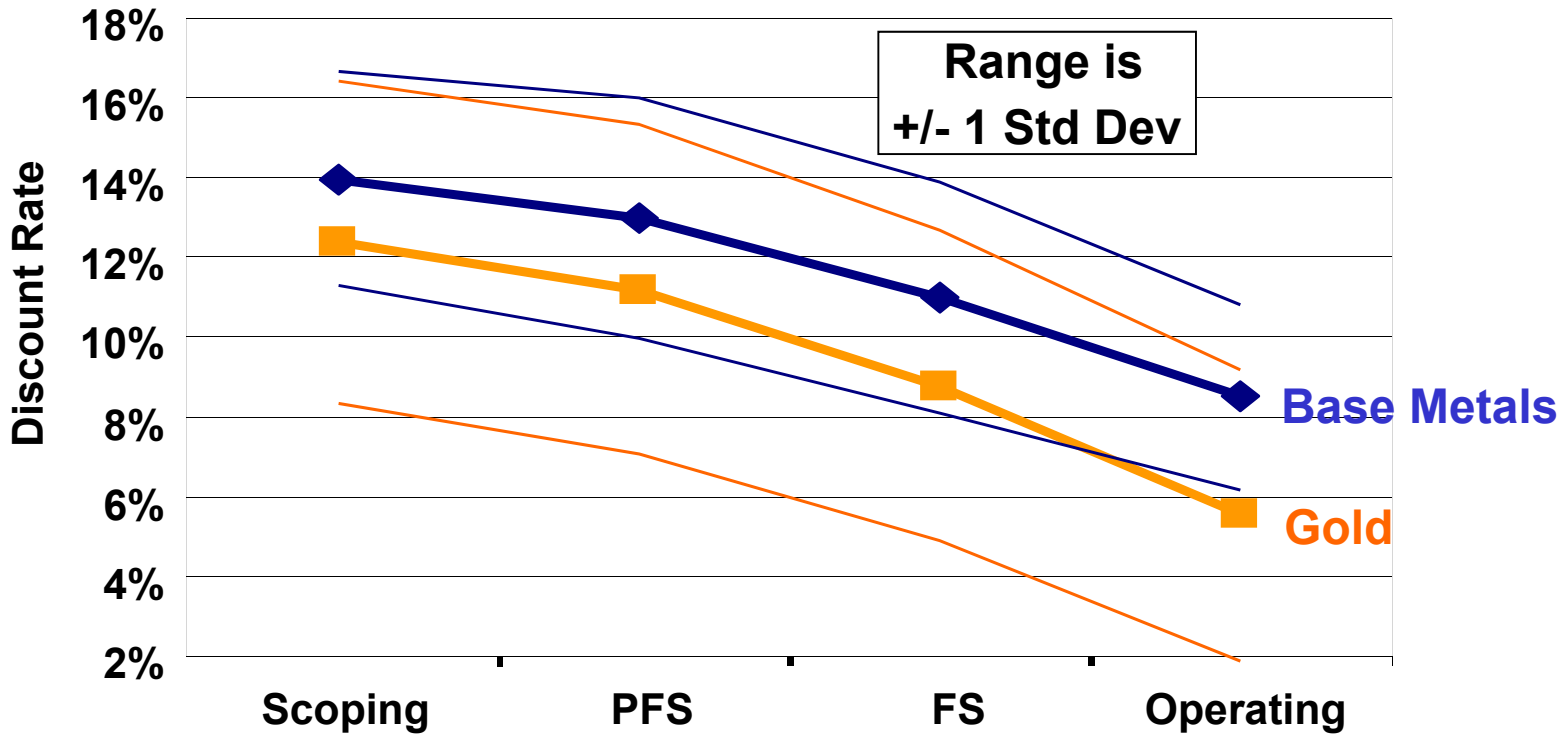




# Discount Rates - RADR
# Risk Adjusting for Different Project Stages (Real)



- This graph shows the combined results of three MES surveys of industry practitioners. The surveys were undertaken to obtain an indication of common industry practice regarding discount rates for project stages.
- Respondents were asked to express their values in real terms.
- The bold lines represent the mathematical averages of the responses. Please note that these results fall within broad bands.








LDSmith CIM-MES Industry Surveys: 1996, 1999, 2005

# Discount Rates - RADR
# Risk Adjusting for Different Project Stages (Real)



- The values below are the mathematical averages of the results of three MES surveys and they fall within broad bands.
- It is assumed that any risks related to an operating mine are included within the WACC and so have a zero increment above the WACC.

- **Gold Projects** - Increment above Operating Mine
  - Operating Mine 0.0% (zero risk increment above WACC)
  - Feasibility Study 3.3%
  - Pre-Feasibility Study 5.7%
  - PEA (Scoping Study) 6.9%

- **Base Metal Projects** - Increment above Operating Mine
  - Operating Mine 0.0% (zero risk increment above WACC)
  - Feasibility Study 2.5%
  - Pre-Feasibility Study 4.5%
  - PEA (Scoping Study) 5.5%



# Discount Rates - RADR
# Risk Adjusting for Technology & Remoteness

- Technical Premium
  - Low Risk 0.0%
  - Moderate risk 0.5%
  - Large risk 1.0%

- Remoteness Premium:
  - Not remote 0.0%
  - Somewhat remote 0.5%
  - Very remote 1.0%





# Discount Rates - RADR
# Risk Adjusting for Country



- Industry practice is to define “safe” jurisdictions as zero risk and to express the risk increment as the difference between sovereign risk ratings of the target jurisdiction and the “safe” jurisdiction.
- For example, Canada, USA, and Australia are generally considered “safe” jurisdictions.
  - Be careful, some states and provinces are less “mining friendly” than the country as a whole and so might be considered higher risk.

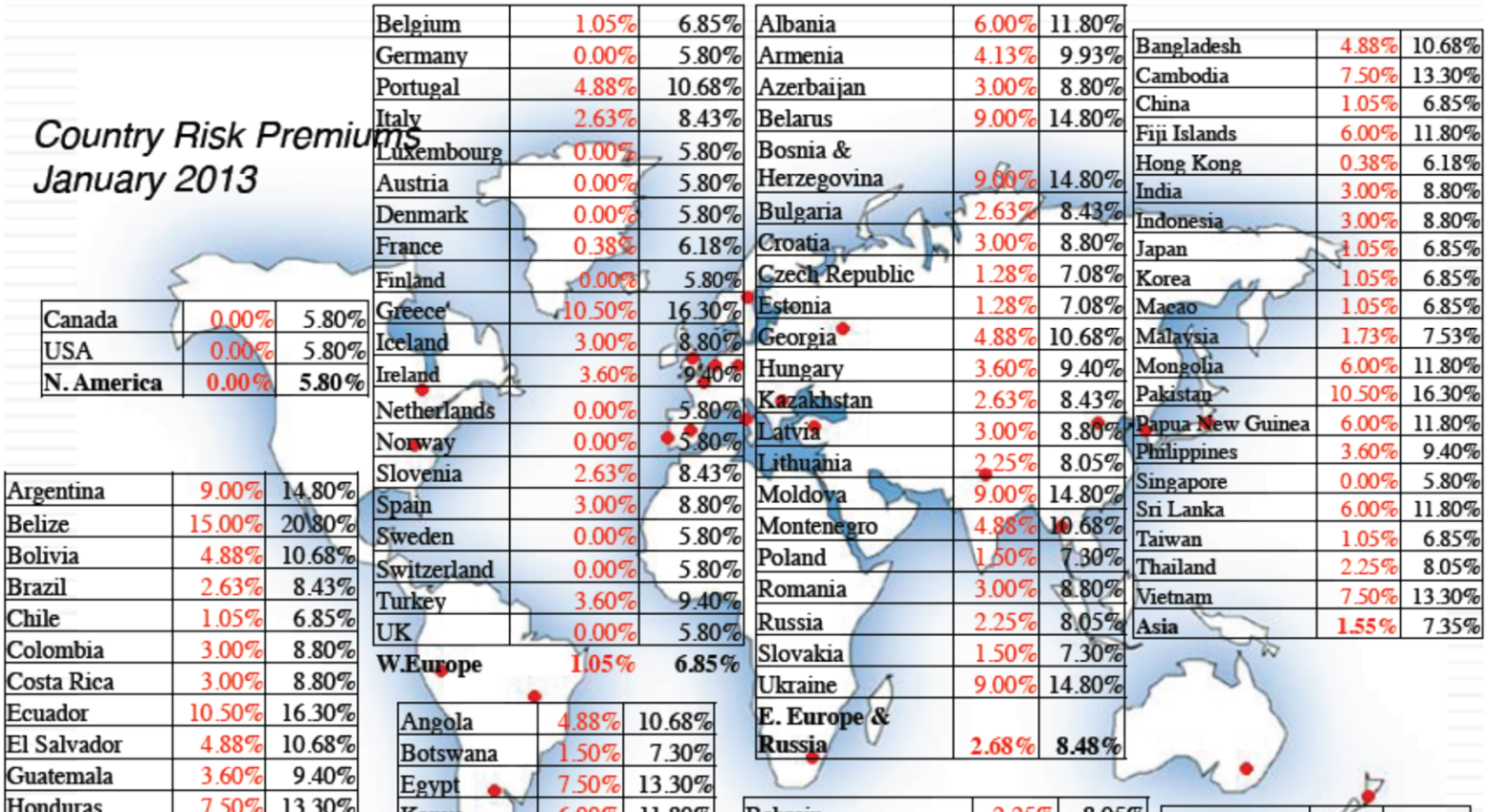
- Example:
  - A Canadian company has a project in another country. Assume the Canadian sovereign risk rate is 5.8% (Damodaran 2013).
  - The project is in a country where the sovereign risk rate is 10.0%
  - The incremental risk premium for the company based in its base in a “safe” jurisdiction would be 4.2% (= 10.0% - 5.8%)

- Note: Some practitioners only add a portion of this sovereign risk increment because some of the risks (metal price, oil prices, large equipment, ocean transportation) are international and not within the target country.



# Discount Rates - RADR
# Country Risk Premiums (ERP=Equity Risk Premium)






| | | |
|---|---|---|
| Canada | 0.00% | 5.80% |
| USA | 0.00% | 5.80% |
| **N. America** | **0.00%** | **5.80%** |

| | | |
|---|---|---|
| Argentina | 9.00% | 14.80% |
| Belize | 15.00% | 20.80% |
| Bolivia | 4.88% | 10.68% |
| Brazil | 2.63% | 8.43% |
| Chile | 1.05% | 6.85% |
| Colombia | 3.00% | 8.80% |
| Costa Rica | 3.00% | 8.80% |
| Ecuador | 10.50% | 16.30% |
| El Salvador | 4.88% | 10.68% |
| Guatemala | 3.60% | 9.40% |
| Honduras | 7.50% | 13.30% |
| Mexico | 2.25% | 8.05% |
| Nicaragua | 9.00% | 14.80% |
| Panama | 2.63% | 8.43% |
| Paraguay | 6.00% | 11.80% |
| Peru | 2.63% | 8.43% |
| Uruguay | 3.00% | 8.80% |
| Venezuela | 6.00% | 11.80% |
| **Latin America** | **3.38%** | **9.18%** |

| | | |
|---|---|---|
| Belgium | 1.05% | 6.85% |
| Germany | 0.00% | 5.80% |
| Portugal | 4.88% | 10.68% |
| Italy | 2.63% | 8.43% |
| Luxembourg | 0.00% | 5.80% |
| Austria | 0.00% | 5.80% |
| Denmark | 0.00% | 5.80% |
| France | 0.38% | 6.18% |
| Finland | 0.00% | 5.80% |
| Greece | 10.50% | 16.30% |
| Iceland | 3.00% | 8.80% |
| Ireland | 3.60% | 9.40% |
| Netherlands | 0.00% | 5.80% |
| Norway | 0.00% | 5.80% |
| Slovenia | 2.63% | 8.43% |
| Spain | 3.00% | 8.80% |
| Sweden | 0.00% | 5.80% |
| Switzerland | 0.00% | 5.80% |
| Turkey | 3.60% | 9.40% |
| UK | 0.00% | 5.80% |
| **W.Europe** | **1.05%** | **6.85%** |

| | | |
|---|---|---|
| Angola | 4.88% | 10.68% |
| Botswana | 1.50% | 7.30% |
| Egypt | 7.50% | 13.30% |
| Kenya | 6.00% | 11.80% |
| Mauritius | 2.25% | 8.05% |
| Morocco | 3.60% | 9.40% |
| Namibia | 3.00% | 8.80% |
| Nigeria | 4.88% | 10.68% |
| Senegal | 6.00% | 11.80% |
| South Africa | 2.25% | 8.05% |
| Tunisia | 3.00% | 8.80% |
| Zambia | 6.00% | 11.80% |
| **Africa** | **4.29%** | **10.09%** |

| | | |
|---|---|---|
| Albania | 6.00% | 11.80% |
| Armenia | 4.13% | 9.93% |
| Azerbaijan | 3.00% | 8.80% |
| Belarus | 9.00% | 14.80% |
| Bosnia & Herzegovina | 9.00% | 14.80% |
| Bulgaria | 2.63% | 8.43% |
| Croatia | 3.00% | 8.80% |
| Czech Republic | 1.28% | 7.08% |
| Estonia | 1.28% | 7.08% |
| Georgia | 4.88% | 10.68% |
| Hungary | 3.60% | 9.40% |
| Kazakhstan | 2.63% | 8.43% |
| Latvia | 3.00% | 8.80% |
| Lithuania | 2.25% | 8.05% |
| Moldova | 9.00% | 14.80% |
| Montenegro | 4.88% | 10.68% |
| Poland | 1.50% | 7.30% |
| Romania | 3.00% | 8.80% |
| Russia | 2.25% | 8.05% |
| Slovakia | 1.50% | 7.30% |
| Ukraine | 9.00% | 14.80% |
| **E. Europe & Russia** | **2.68%** | **8.48%** |

| | | |
|---|---|---|
| Bahrain | 2.25% | 8.05% |
| Israel | 1.28% | 7.08% |
| Jordan | 4.13% | 9.93% |
| Kuwait | 0.75% | 6.55% |
| Lebanon | 6.00% | 11.80% |
| Oman | 1.28% | 7.08% |
| Qatar | 0.75% | 6.55% |
| Saudi Arabia | 1.05% | 6.85% |
| United Arab Emirates | 0.75% | 6.55% |
| **Middle East** | **1.16%** | **6.96%** |

| | | |
|---|---|---|
| Bangladesh | 4.88% | 10.68% |
| Cambodia | 7.50% | 13.30% |
| China | 1.05% | 6.85% |
| Fiji Islands | 6.00% | 11.80% |
| Hong Kong | 0.38% | 6.18% |
| India | 3.00% | 8.80% |
| Indonesia | 3.00% | 8.80% |
| Japan | 1.05% | 6.85% |
| Korea | 1.05% | 6.85% |
| Macao | 1.05% | 6.85% |
| Malaysia | 1.73% | 7.53% |
| Mongolia | 6.00% | 11.80% |
| Pakistan | 10.50% | 16.30% |
| Papua New Guinea | 6.00% | 11.80% |
| Philippines | 3.60% | 9.40% |
| Singapore | 0.00% | 5.80% |
| Sri Lanka | 6.00% | 11.80% |
| Taiwan | 1.05% | 6.85% |
| Thailand | 2.25% | 8.05% |
| Vietnam | 7.50% | 13.30% |
| **Asia** | **1.55%** | **7.35%** |

| | | |
|---|---|---|
| Australia | 0.00% | 5.80% |
| New Zealand | 0.00% | 5.80% |
| **Australia & NZ** | **0.00%** | **5.80%** |

*Black #: Total ERP*
*Red #: Country risk premium*
*AVG: GDP weighted average*

# Discount Rates - RADR Examples





| Item or Risk Adjustment | Gold FS | Gold Operating | Copper in Gold Company FS | Copper in Copper Company FS | Copper in Gold Company FS |
|---|---|---|---|---|---|
| WACC | 5.0% | 5.0% | 5.0% | 7.0% | 5.0% |
| Metal | - | - | 2.0% | - | 2.0% |
| Stage | 3.3% | - | 2.5% | 2.5% | 2.5% |
| Other | - | - | 1.0% | 1.0% | 2.0% |
| Country Risk | - | 2.0% | - | - | 7.5% |
| RADR | 8.3% | 7.0% | 10.5% | 10.5% | 19.0% |

All values are in real terms

WACC is the expected return for the company

RADR is the Risk Adjusted Discount Rate for the project

Using WACC assumes the project is funded from general corporate funds.



# A Fundamental Problem?

# Risk Adjusted Discount Rates

- The use of a Risk Adjusted Discount Rate is standard industry practice:
  - Develop the RADR
  - Apply the same RAADR to all items in the cash flow by applying it to the overall net cash flow.
  - Apply the same RADR in all years

- But
- Risk Adjusted Discount Rate is a rather blunt instrument.
  - The risk adjustment is applied equally to all cash flow items.
  - No consideration to possible variations in their levels of risk.

- And…
- **Is there a fundamental problem with the basic concept?**
- **Is there a fundamental problem with the math?**





# Discounted Cost Flows
# A Problem With The Math?



- Consider a comparison of Owner versus Contractor water transport options.
- The analysis showed that the contracted trucks had a lower Net Present Cost at the project's 5% discount rate and so was the favoured option.
- But the engineer indicated that this did not sound right as the contractor option was deemed to be more risky.
- To reflect increased risk the discount rate for the riskier option was increased to 8% which reduced the Net Present Cost and favoured the contracted trucks even more.

Original Results

| Cost Flows | Net Present Costs | | | |
|---|---|---|---|---|
| Discount Rate | 0.0% | 5.0% | 8.0% | 10.0% |
| Owner Trucks | 73.8 | 52.4 | 44.1 | 39.8 |
| Contract Trucks | 76.8 | 50.6 | 40.6 | 35.4 |

The Solution?

| Discount Rate | 0.0% | 5.0% | 8.0% | 10.0% |
|---|---|---|---|---|
| Owner Trucks | 73.8 | 52.4 | 44.1 | 39.8 |
| Contract Trucks | 76.8 | 50.6 | 40.6 | 35.4 |

- Question: Why? What is wrong with this picture?
- Answer: With costs, discounting works the opposite to what is expected .



# Risk Adjusted Discount Rates
# Discounted Cash Flows

- If discounting costs works in the opposite direction of what is expected:
  - How does this impact the costs in a cash flow?
  - What does one see if one goes back and takes a second look?
  - Does the same pattern show up?

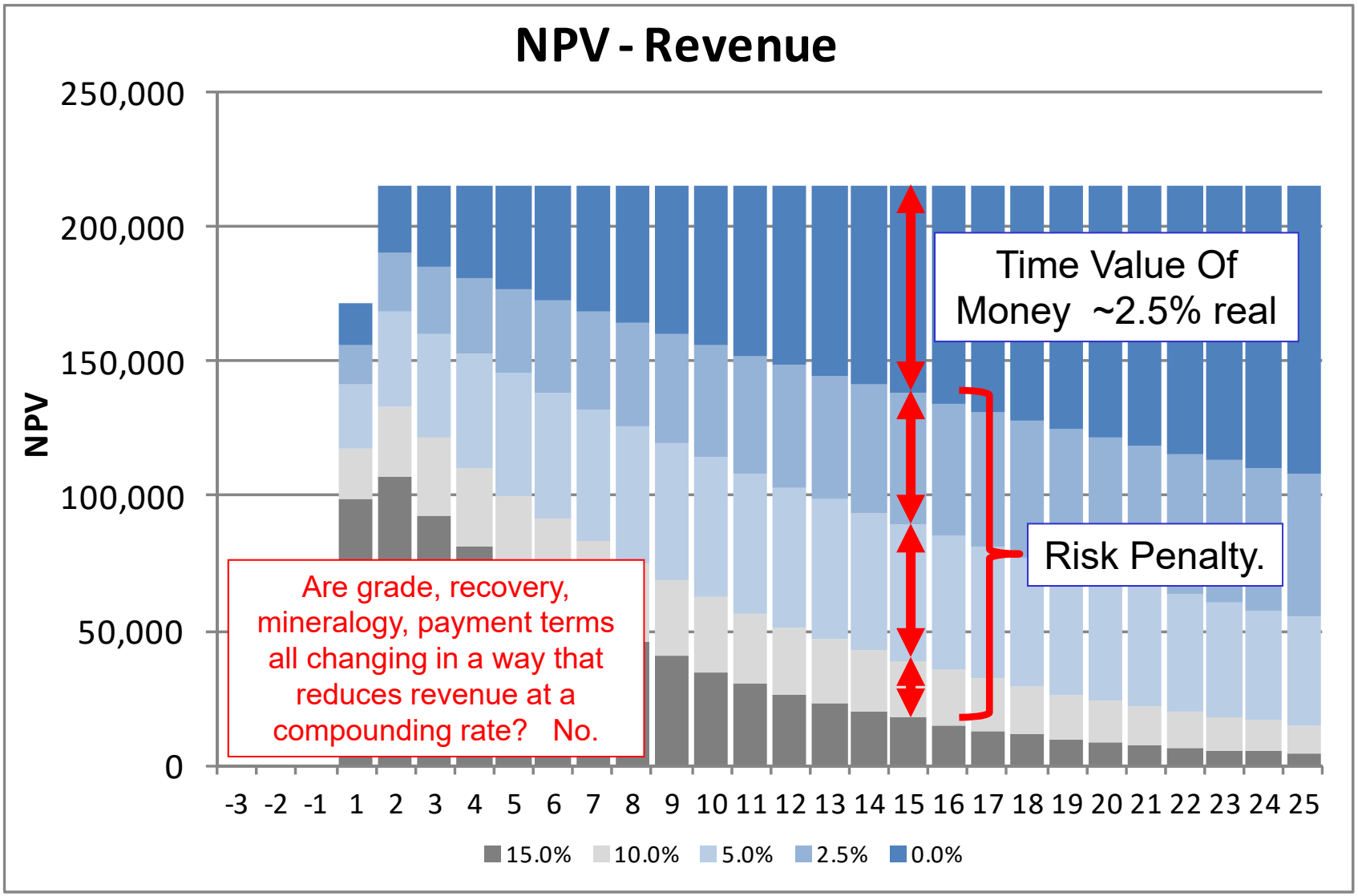
- **Let's take a closer look . . .**



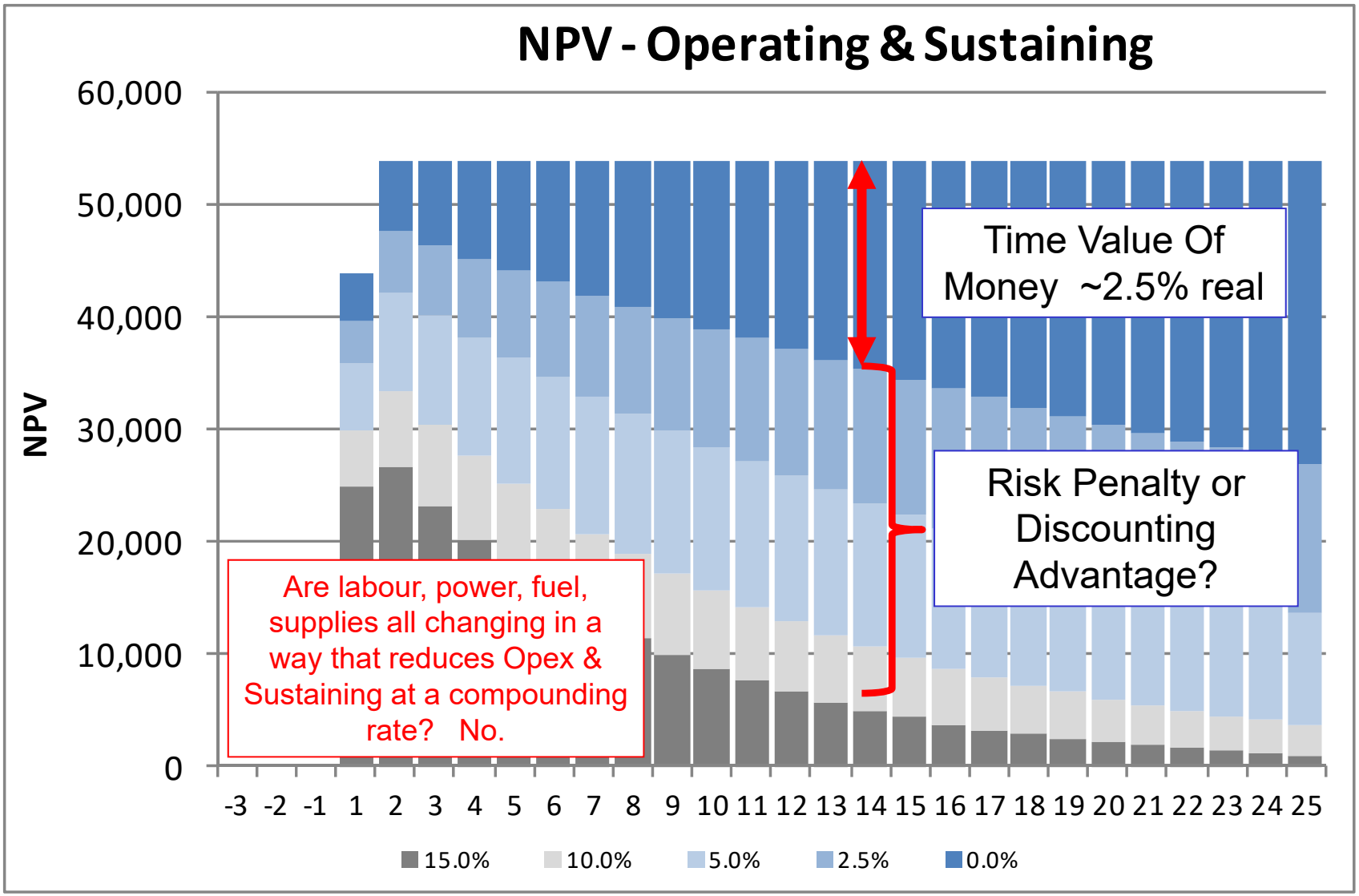


# Discounted Cash Flow Components
# Risk Adjusted Revenue

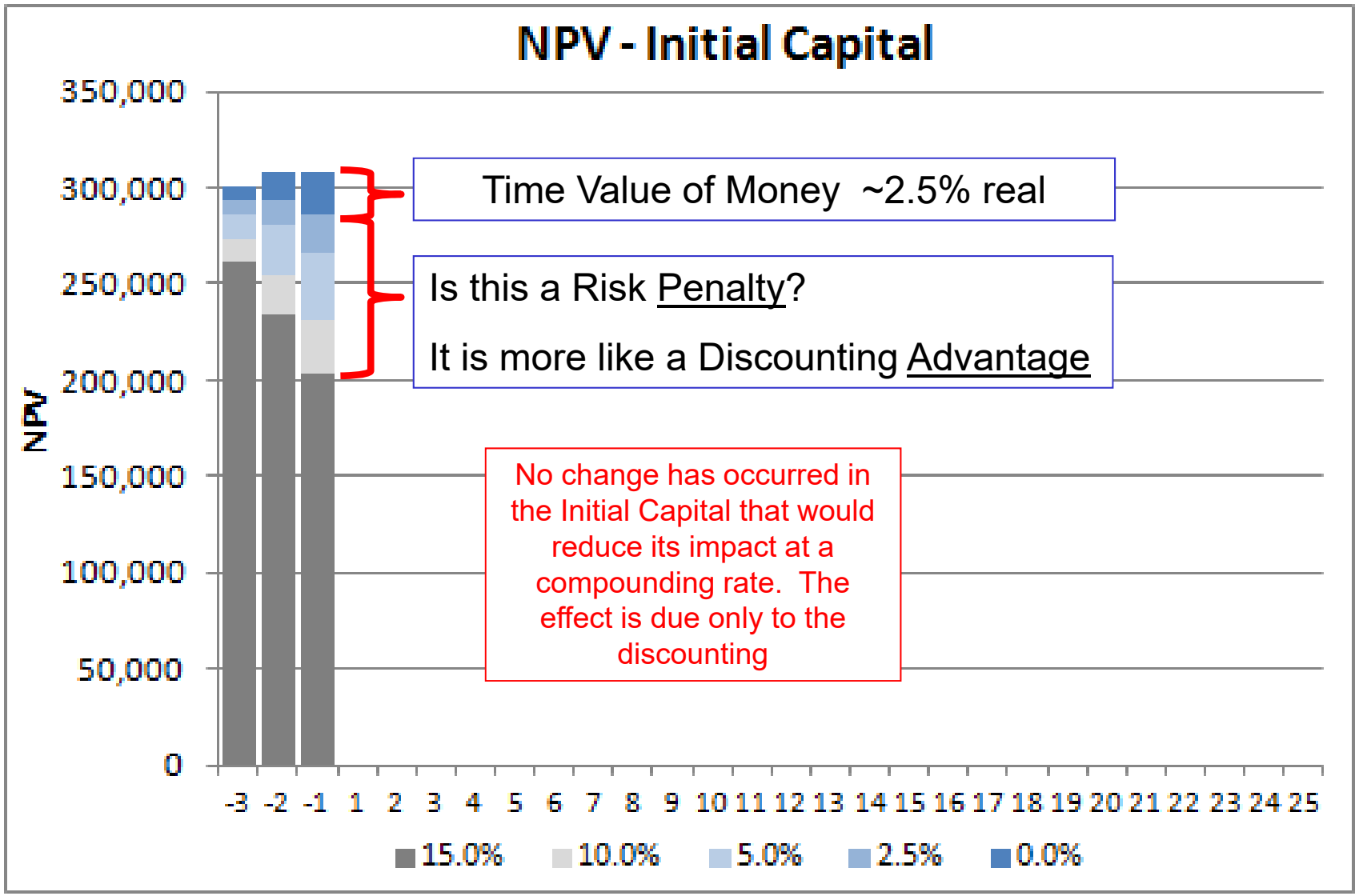




# Discounted Cash Flow Components
# Risk Adjusted Operating & Sustaining Costs



# Discounted Cash Flow Components
# Risk Adjusted Initial Capital Costs



# Discounted Cash Flow Components
# Is this really what we want to happen?

- Conventional Risk Adjusted Discount Rates appear to be:
  - Addressing the time value of money
  - Applying a compounding risk penalty on revenue and other positive cash flows
  - Applying a compounding risk advantage on costs and other negative cash flows.
  - Is this what we really want discounting to do?

- Let's look at the math.





# Discounting
## What is actually happening in the math?



| Discounted Cash Flows | 0.0% | 2.5% | 5.0% | 10.0% | 15.0% |
|---|---|---|---|---|---|
| Concentrate Net Smelter Return | 3,647.4 | 2,524.3 | 1,810.3 | 1,021.4 | 636.6 |
| Dore Net Revenue | 1,492.4 | 1,032.8 | 740.7 | 417.9 | 260.5 |
| Revenue | 5,139.8 | 3,557.1 | 2,551.0 | 1,439.3 | 897.1 |
| Operating Costs | -1,181.8 | -818.7 | -587.7 | -331.9 | -207.0 |
| NSR Royalty | -77.1 | -53.4 | -38.3 | -21.6 | -13.5 |
| Operating Cash Flow | 3,880.9 | 2,685.0 | 1,925.1 | 1,085.8 | 676.6 |
| Capital - Initial | -917.9 | -873.7 | -832.9 | -760.3 | -697.8 |
| Capital - Sustaining | -79.2 | -54.8 | -39.3 | -22.3 | -14.0 |
| Capital - Decommissioning | -17.0 | -8.5 | -4.3 | -1.2 | -0.3 |
| Change in Working Capital | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Cash Flow Before Taxes | 2,866.8 | 1,748.0 | 1,048.5 | 302.0 | -35.5 |
| Income & Mining Tax | -1,190.2 | -780.8 | -527.0 | -259.1 | -138.9 |
| Total Cash Flow | 1,676.6 | 967.2 | 521.4 | 42.9 | -174.3 |

For illustration purposes 5% (real) is used in the following examples. It is a typical rate used by analysts for operating gold companies.



# Risk Adjusted Net Present Values
# Is this what we want to happen?



| Risk Adjusted Cash Flows | NPV | Factor | RADR NPV |
|---|---|---|---|
| | 5.0% | | 11.3% |
| Concentrate Net Smelter Return | 1,810.3 | 0.49 | 895.6 |
| Dore Net Revenue | 740.7 | 0.49 | 366.5 |
| Revenue | 2,551.0 | 0.49 | 1,262.1 |
| Operating Costs | -587.7 | 0.50 | -291.1 |
| NSR Royalty | -38.3 | 0.49 | -18.9 |
| Operating Cash Flow | 1,925.1 | 0.49 | 952.0 |
| Capital - Initial | -832.9 | 0.89 | -743.2 |
| Capital - Sustaining | -39.3 | 0.50 | -19.6 |
| Capital - Decommissioning | -4.3 | 0.20 | -0.8 |
| Change in Working Capital | 0.0 | 0.00 | 0.0 |
| Cash Flow Before Taxes | 1,048.5 | 0.18 | 188.5 |
| Income & Mining Tax | -527.0 | 0.41 | -218.7 |
| Total Cash Flow | 521.4 | -0.06 | -30.2 |

**Do we really want to reduce revenue this much?**

**Do we really want to <u>REDUCE</u> the Opex this much?**

**Do we really want to <u>REDUCE</u> the impact of Initial Capital in a riskier project?**

11.3% = RADR for a gold company with a base metal project at the Feasibility Study stage in moderate risk country.



# A Proposed Solution

# Risk Adjusted Net Present Value
# Isn't this what we really want to happen?



| Risk Adjusted Cash Flows | | 5.0% | Factor | RANPV | RADR NPV 11.3% |
|---|---|---|---|---|---|
| Concentrate Net Smelter Return | | 1,810.3 | 0.95 | 1,719.8 | 895.6 |
| Dore Net Revenue | | 740.7 | 0.97 | 718.5 | 366.5 |
| Revenue | | 2,551.0 | | 2,438.2 | 1,262.1 |
| Operating Costs | | -587.7 | 1.05 | -617.0 | -291.1 |
| NSR Royalty | | -38.3 | 1.00 | -38.3 | -18.9 |
| Operating Cash Flow | | 1,925.1 | | 1,782.9 | 952.0 |
| Capital - Initial | | -832.9 | 1.25 | -1,041.1 | -743.2 |
| Capital - Sustaining | | -39.3 | 1.10 | -43.3 | -19.6 |
| Capital - Decommissioning | | -4.3 | 1.50 | -6.5 | -0.8 |
| Change in Working Capital | | 0.0 | 1.00 | 0.0 | 0.0 |
| Cash Flow Before Taxes | | 1,048.5 | | 692.0 | 188.5 |
| Income & Mining Tax | 50.3% | -527.0 | 1.00 | -347.9 | -218.7 |
| Total Cash Flow | | 521.4 | | 344.2 | -30.2 |

**Risk Adjusted NPV**



# Discounted Cash Flow Components
# Isn't this what we really want to happen?

- The Risk Adjusted NPV approach is to:
  - Use a "risk free" discount rate that contains minimum risk characteristics so that the NPV only reflects the time value of money
  - Apply risk factors to the "risk free" NPVs

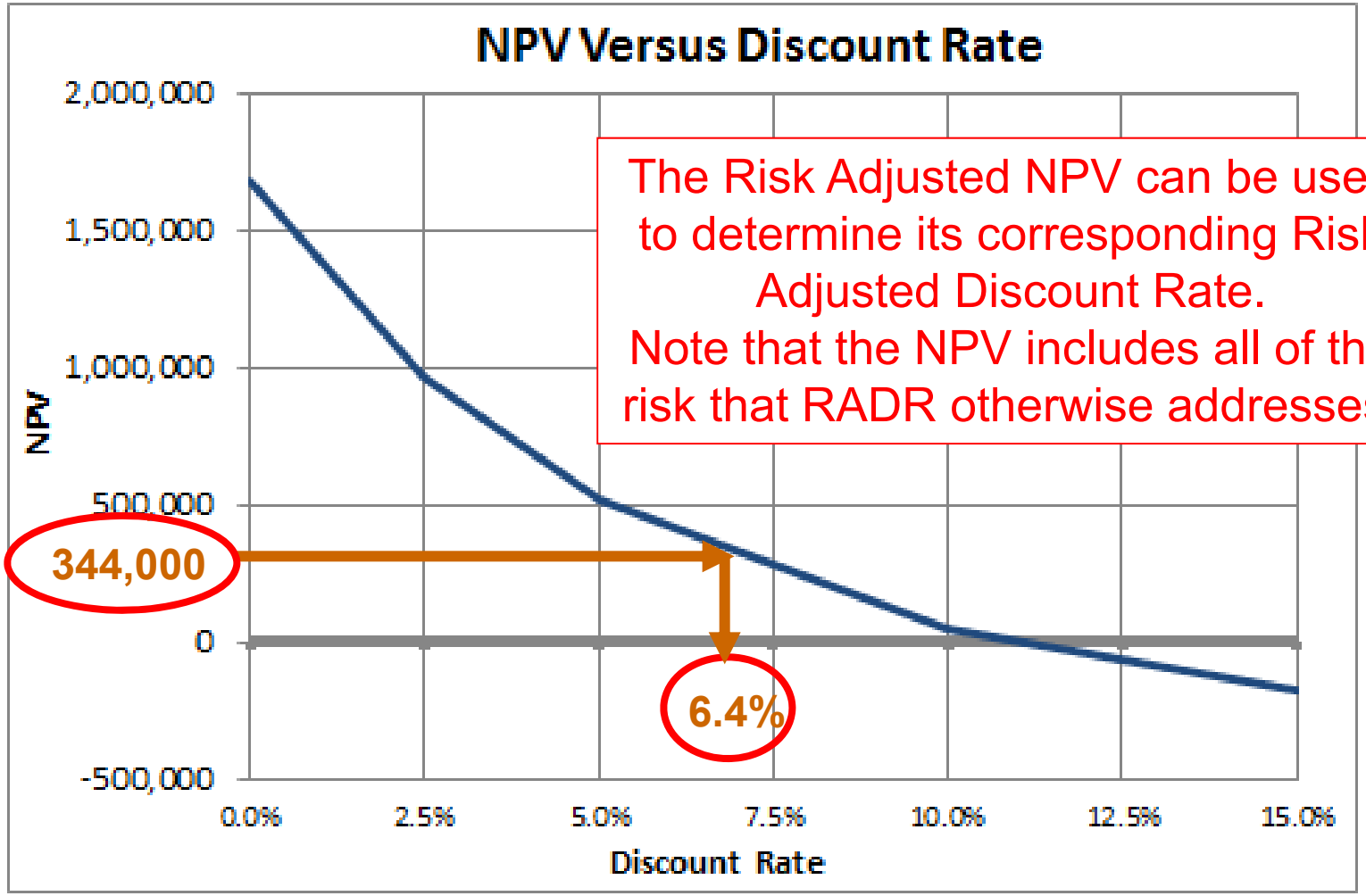
- Note:
  - This approach uses the same discount rate for all items.
  - This approach uses the same discount rate for each year.
  - This approach **DOES NOT** use a different discount rate for each item.





# Risk Adjusted Net Present Value
# NPV vs Discount Rate





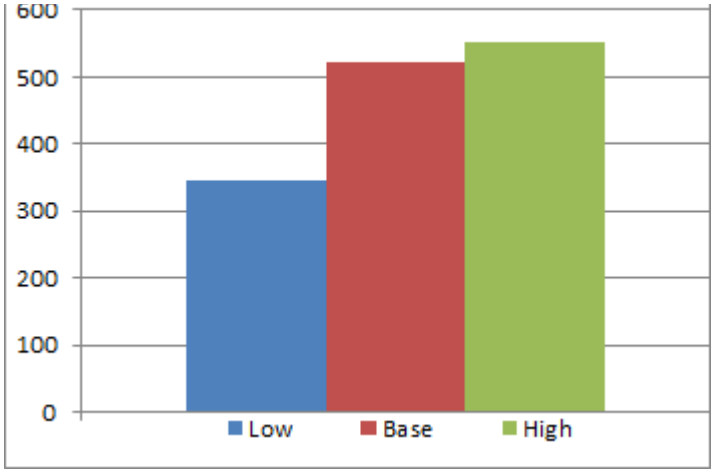

The Risk Adjusted NPV can be used to determine its corresponding Risk Adjusted Discount Rate.
Note that the NPV includes all of the risk that RADR otherwise addresses.



# Risk Adjusted Net Present Value
# Develop A Range Of Outcomes With High/Low Cases



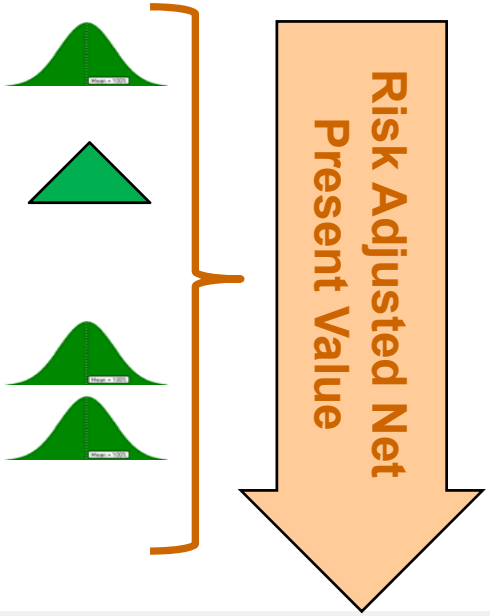
| | | Base | Low | High | Low | High |
|---|---|---|---|---|---|---|
| Risk Adjusted Cash Flows | | 5.0% | RANPV | RANPV | Factors | Factors |
| Concentrate Net Smelter Return | | 1,810.3 | 1,719.8 | 1,828.4 | 0.95 | 1.01 |
| Dore Net Revenue | | 740.7 | 718.5 | 748.1 | 0.97 | 1.01 |
| Revenue | | 2,551.0 | 2,438.2 | 2,576.5 | | |
| Operating Costs | | -587.7 | -617.0 | -570.0 | 1.05 | 0.97 |
| NSR Royalty | | -38.3 | -38.3 | -38.3 | 1.00 | 1.00 |
| Operating Cash Flow | | 1,925.1 | 1,782.9 | 1,968.2 | | |
| Capital - Initial | | -832.9 | -1,041.1 | -816.2 | 1.25 | 0.98 |
| Capital - Sustaining | | -39.3 | -43.3 | -38.5 | 1.10 | 0.98 |
| Capital - Decommissioning | | -4.3 | -6.5 | -4.3 | 1.50 | 1.00 |
| Change in Working Capital | | 0.0 | 0.0 | 0.0 | 1.00 | 1.00 |
| Cash Flow Before Taxes | | 1,048.5 | 692.0 | 1,109.1 | | |
| Income & Mining Tax | 50.3% | -527.0 | -347.9 | -557.5 | | |
| Total Cash Flow | | 521.4 | 344.2 | 551.6 | | |

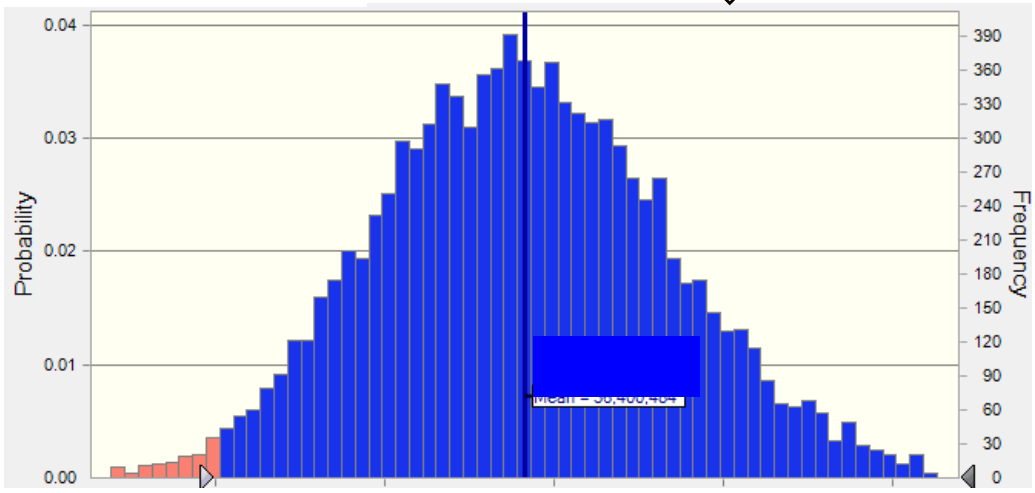


# Risk Adjusted Net Present Values
# Develop A Range Of Outcomes With Monte Carlo



| Risk Adjusted Cash Flows | | 5.0% | Factor |
|---|---|---|---|
| Concentrate Net Smelter Return | | 1,810.3 | |
| Dore Net Revenue | | 740.7 | |
| Revenue | | 2,551.0 | |
| Operating Costs | | -587.7 | |
| NSR Royalty | | -38.3 | |
| Operating Cash Flow | | 1,925.1 | |
| Capital - Initial | | -832.9 | |
| Capital - Sustaining | | -39.3 | |
| Capital - Decommissioning | | -4.3 | |
| Change in Working Capital | | 0.0 | |
| Cash Flow Before Taxes | | 1,048.5 | |
| Income & Mining Tax | 50.3% | -527.0 | |
| Total Cash Flow | | 521.4 | |



# Determining The Risk Factors

# Risk Adjusted Net Present Values
# Determining the Factors - Revenue

| Component | Sources & Ranges |
|---|---|
| Price | Recommend assessing three approaches:<br>**1) Always run a flat long-term price case;**<br>2) test prices to find break-even price;<br>3) price forecasting techniques including regressing & non-regressing stochastic methods |
| Tonnes | +/- range based on reserves and/or resources |
| Grade | +/- range based on reserves and/or resources |
| Recovery | Confidence levels in recovery curves & test work |
| Payment terms | Smelter contract & refinery terms; product freight |
| Process Technology | Recovery risk with new technology |
| Ramp-Up | McNulty Curves |
| Delays | Delays in metal payment (private & government) |





# Risk Adjusted Net Present Values
# Determining the Factors – Operating Costs

| Component | Sources & Ranges |
|---|---|
| Labour | Labour rates, productivity |
| Power | Power contract; range of possible values (due to market forces as opposed to escalation) |
| Fuel | Brent or WTI trends and sensitivities (due to market forces as opposed to escalation) |
| Consumables | Wide range of products that may be impacted by supply, demand |
| Delivered Cost | Freight, tariffs, duties |
| Quality of Estimate | Scoping, Pre-Feasibility, Feasibility, Operation |

# Risk Adjusted Net Present Values
# Determining the Factors – Capital Costs

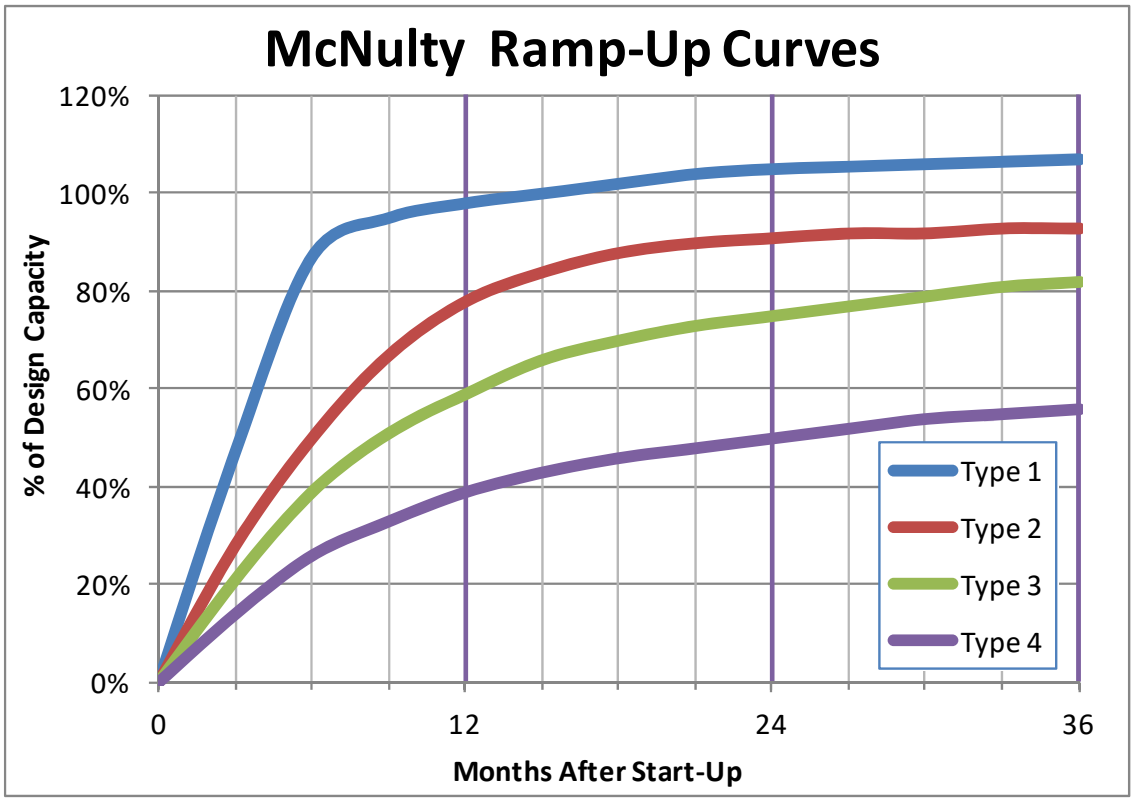


| Component | Sources & Ranges |
|---|---|
| Labour | Labour rates, productivity |
| Quantities | Basis & Quality of estimate |
| Unit Costs | Basis & Quality of estimate |
| Schedule | Productivity, camp quality, winter works |
| Earthworks | “The devil is in the dirt” |
| Remoteness | Elevation; Arctic; Third World |
| Technology | Difficult installations; Skilled workers |
| Delivered Costs | Freight, tariffs, duties |
| Management | Skilled and experienced people |
| Execution | Skilled People; EPCM or Owner? |
| Quality of Estimate | Scoping, Pre-Feasibility, Feasibility, Operation; AACE Accuracy and Contingency ranges |



# Risk Adjusted Net Present Values
# Determining the Factors – Revenue & Ramp-Up





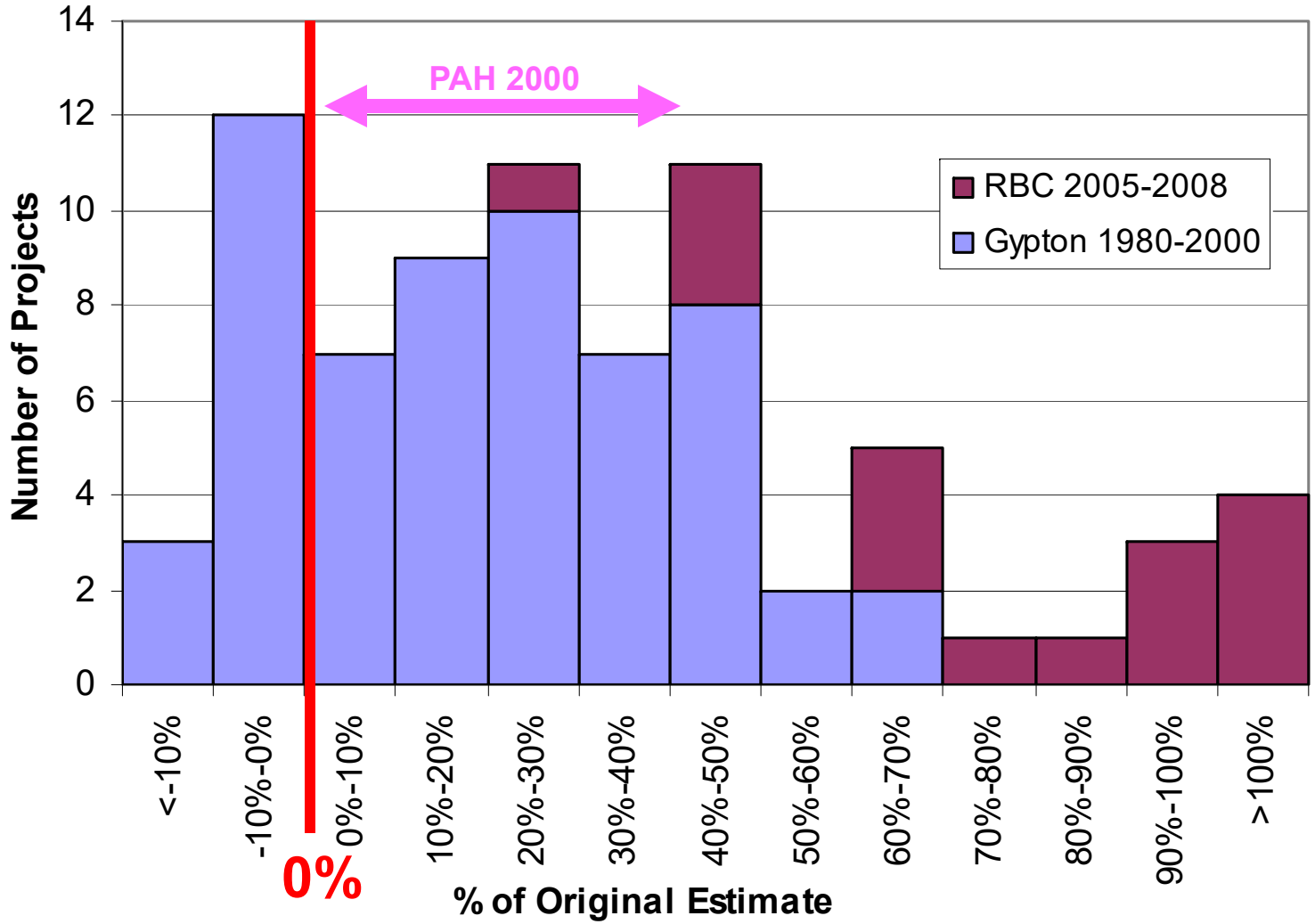

| | |
|---|---|
| Type 1 | Well proven. Mature technology. Used elsewhere. Similar scale |
| Type 2 | Well demonstrated components to be integrated in a new way. Similar scale |
| Type 3 | Adaptation to new circumstances or new scale. Limited pilot testing or limited knowledge of feed variation |
| Type 4 | New. First time implementation. Complex flow sheet. |



After McNulty, Mining Engineering, Oct 1998
C Twigge-Molecey ,CIM Management & Finance Day, 2012

# Risk Adjusted Net Present Values
# Determining the Factors – Capital How Have We Done?






C. Gypton, E&MJ - 1Jan02
Pincock Perspectives #12, Nov00
RBC - Capital Punishment - 3Apr08

# Risk Adjusted Net Present Values
# Determining The Factors – Other Items

- **Remoteness**
  - High elevation (usually accompanied by severe weather)
  - Arctic (with severe weather conditions)
  - Third world (accompanied by poor infrastructure and political instability)
  - **Suggest adding up to 50% to costs and schedule.**
- **Unconventionality**
  - New process, construction or engineering concepts.
  - Problems with ramp-up and reaching full capacity.
  - **Suggest adding up to 50% to costs and schedule.**
- **Earthwork**
  - "The devil is in the dirt."
  - **Suggest adding up to 100% to earthwork capital budget.**
- **Schedule**
  - **Suggest adding ~ 10% to the schedule and increase the capital cost to reflect this delay (in addition to the effects noted above)**





# Risk Adjusted Net Present Values
# Determining the Factors - Country Risk



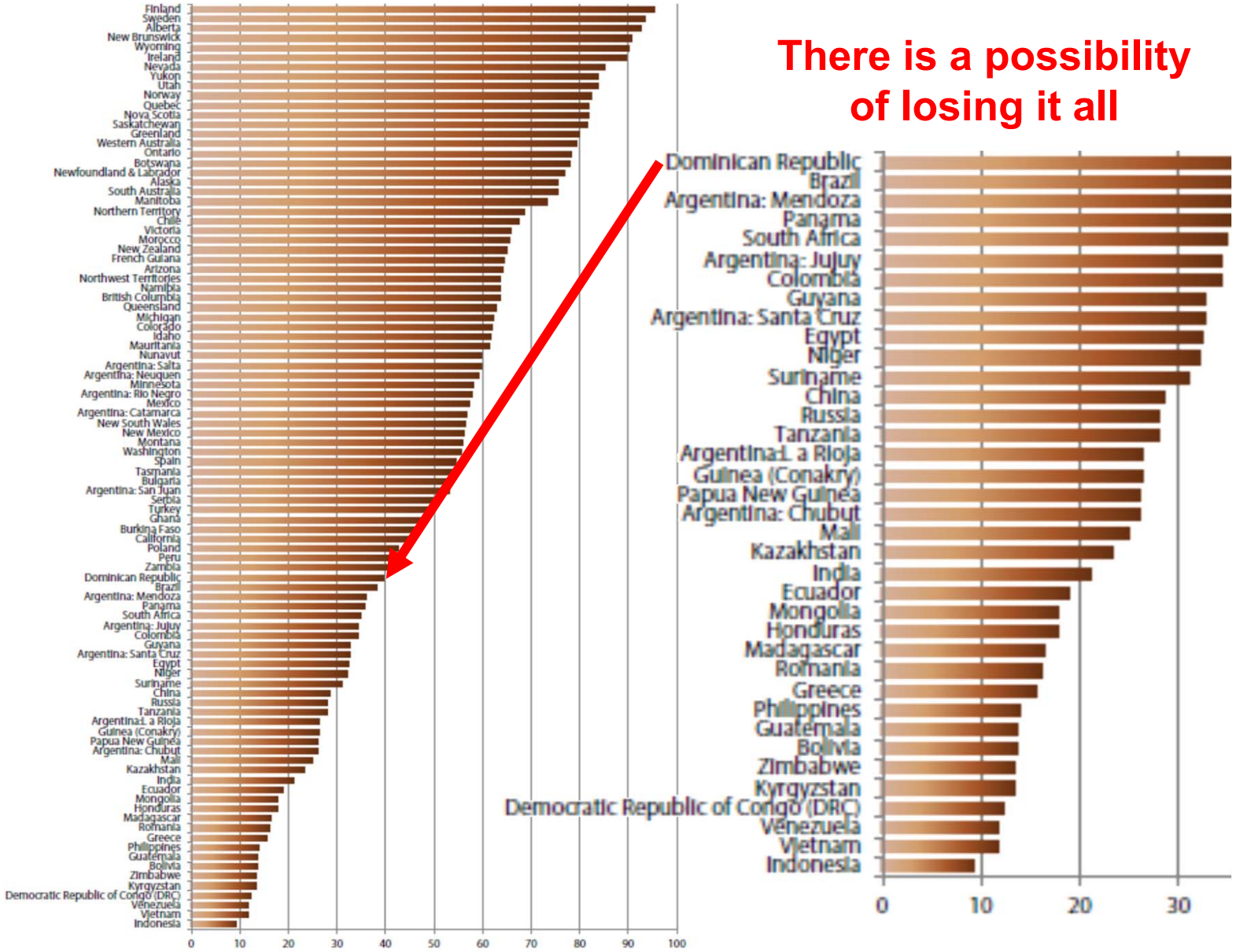
- Traditionally country risk has been included in the discount rate because:
  - the ranking is provided as an interest rate
  - that is how the lending institutions have assessed risks for sovereign loans
- Mining companies using sovereign risk rankings have long recognized that not all of their risks occur within the country where the mine is located:
  - Metal prices are international
  - Equipment, fuel and consumable prices are largely driven by the international market
- **Country risks these days are associated with resource nationalism:**
  - **Increased taxes**
  - **Windfall taxes**
  - **Withholding taxes**
  - **Outright expropriation of the asset**
- Can these be adequately captured by a discount rate?
- Would a probability factor be more appropriate?



# Risk Adjusted Net Present Values
# Determining The Factors - Country Risk










Fraser Institute Survey – Policy Potential - 2012-2013

# Conclusions

# Where is Risk Best Addressed?
# Risk Adjusting Cash Flows & Discount Rates



| Risk | Cash Flow | Discount Rate |
|---|---|---|
| Time Value of Money | X | Yes |
| Reserves & Resources | Yes | X |
| Tonnes and Grade | Yes | X |
| Metal Prices & Market | Yes | X |
| Metallurgical  Recovery & Issues | Yes | X |
| Initial Capital | Yes | X |
| Technical Risk & Remoteness | Yes | X |
| Execution Risk | Yes | X |
| Foreign Exchange in Estimates | Yes | X |
| Royalties | Yes | X |
| Operating & Sustaining | Yes | X |
| Stage of Development | Yes | X |
| Taxes | Yes | **NEVER!** |
| Country Risk | Possibly | Likely |



# Risk Adjusted Net Present Values
# Where To From Here?



- Risk adjusting cash flows in the source data:
  - Is a better way to reflect risk for most technical and cost issues.
  - Is how we address risk with scenario cases.
  - But,
  - The results will look worse than competing projects that do not risk adjust their cash flows.

- Risk Adjusting NPV with a risk free discount rate (suggest WACC):
  - Corrects the RADR Paradox with costs.
  - Corrects the deteriorating impact of long term compounding.
  - Is effectively what we do when we calculate NPV using Monte Carlo.
  - Uses risk factors that are available from statistical and historical assessments of operations, projects, and industry practice.
  - But,
  - The method and protocols are not well established yet.
  - There is little industry practice to use as a reference.
  - It is not what the industry is used to.



# Risk Adjusted Net Present Values
# Where To From Here?



Recommendation:

- Accept that RANPV will not replace the RADR approach in the short term.
- Continue the RADR approach for calculating NPV.
- In parallel, calculate the Risk Adjusted Net Present Values:
  - To begin to develop a meaningful experience of values.
  - To socialize the concept with management.

- Compare and Report:
  - Risk Adjusted Net Present Value
  - Risk Adjusted Discount Rate (RADR) NPV

- The RANPV alternate view has advantages:
  - RANPV may highlight understated, or overstated, value.
  - **If everyone else is using RADR NPVs to value a project, you may spot more value using Risk Adjusted NPV**



# Risk Adjusted Net Present Values
# Where To From Here?

What do we do with *"tried and true"* RADR?

- Keep using it as a reference point because we are used to it
- Use it as the hurdle rate for threshold levels for IRR

**Parting Thought**

The Risk Adjusted Net Present Value approach will face resistance:

- *"It's not what we have always done!"*
- **Given the industry's track record of projects and valuations . . . what better reason to try Risk Adjusted Net Present Values than "it's not what we have always done"?**





# Questions?

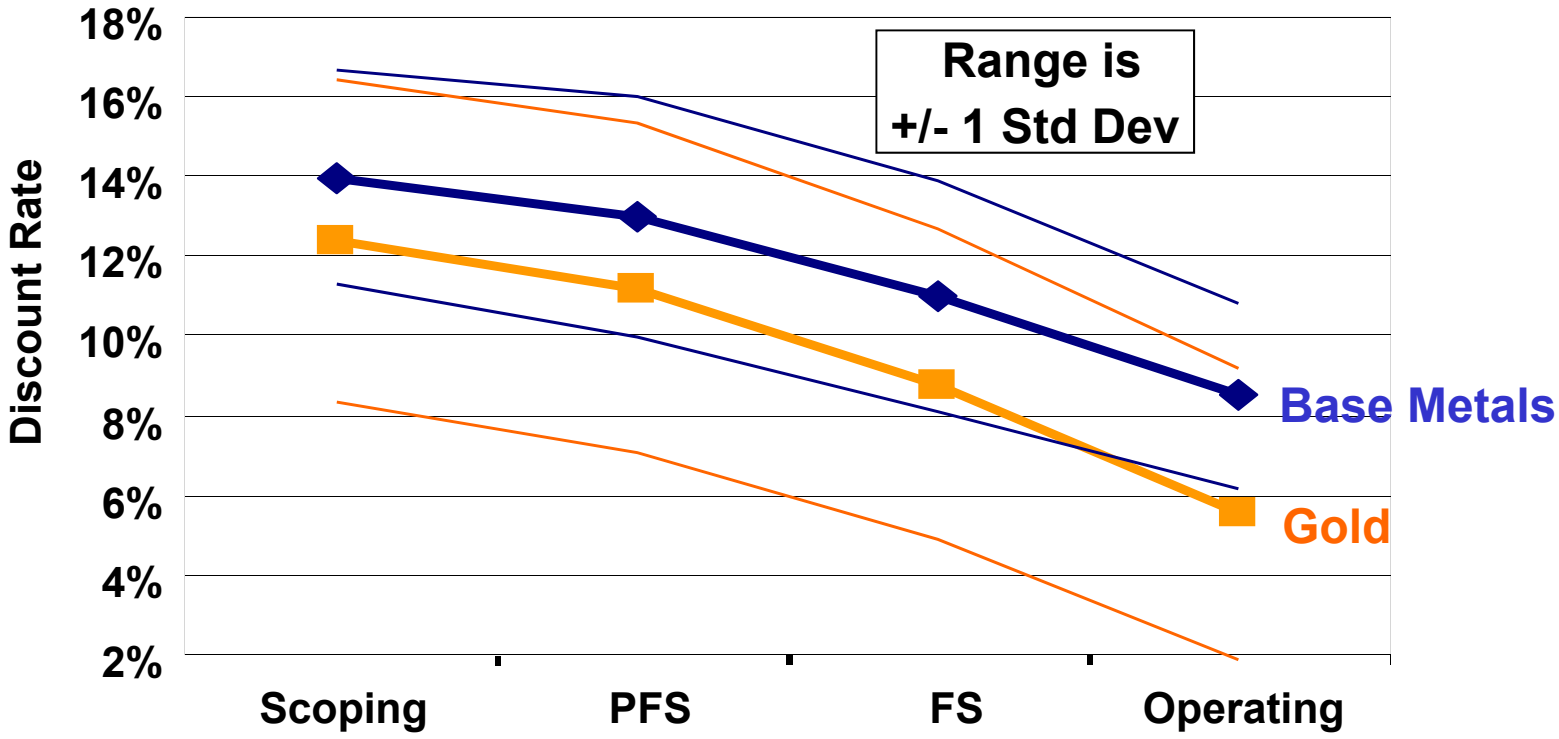


# Notes



# Discount Rates - RADR
# Risk Adjusting for Different Project Stages (Real)






| Level of Study | Gold | Δ | Base Metals | Δ |
|---|---|---|---|---|
| Scoping | 12.4% | **6.9%** | 14.0% | **5.5%** |
| Pre-Feasibility | 11.2% | **5.7%** | 13.0% | **4.5%** |
| Feasibility | 8.8% | **3.3%** | 11.0% | **2.5%** |
| Operating Mine | 5.5% | **0.0%** | 8.5% | **0.0%** |





LDSmith CIM-MES Industry Surveys: 1996, 1999, 2005

# Risk Adjusted Discount Rates In Finance Text Books



- How did this mathematical inconsistency become part of our standard practice?
- Where did the idea of risk adjusted discount rates come from?

- The answer can be seen in most finance text books:
  - The math is based on an investment at a single point in time.
    - The single investment occurs at t=0 so it is not discounted.
  - Repayments follow over a series of years coming from an unspecified source (not as a cash flow with revenue and operating costs).
    - If the borrower is “safe” a low RADR is used.
    - If the borrower is risky, the RADR is high to ensure that the lender recovers capital as repayments or as interest before the risky borrower has the opportunity to default.

- Mining project cash flows do not follow this ideal pattern:
  - Mining initial investments are spread over many years
  - Mining repayments are the net of revenue, operating costs, and taxes.
    - Revenue & costs do not reduce continuously on a compounding basis.



# Discount Rates - RADR Example



| Item or Risk Adjustment | Base Metal Project in Gold Company |
|---|---|
| WACC | 5.0% |
| Metal | 2.0% |
| Stage (FS) | 2.5% |
| Other | - |
| Country Risk | 1.8% |
| RADR | 11.3% |

All values are in real terms

WACC is the expected return for the company

RADR is the Risk Adjusted Discount Rate for the project

Using WACC assumes the project is funded from general corporate funds.

# Risk Adjusted Net Present Values
# Going One Step Further – Add Schedule Delay

- Expand the single "Factor" to reflect uncertainty, schedule, and risks

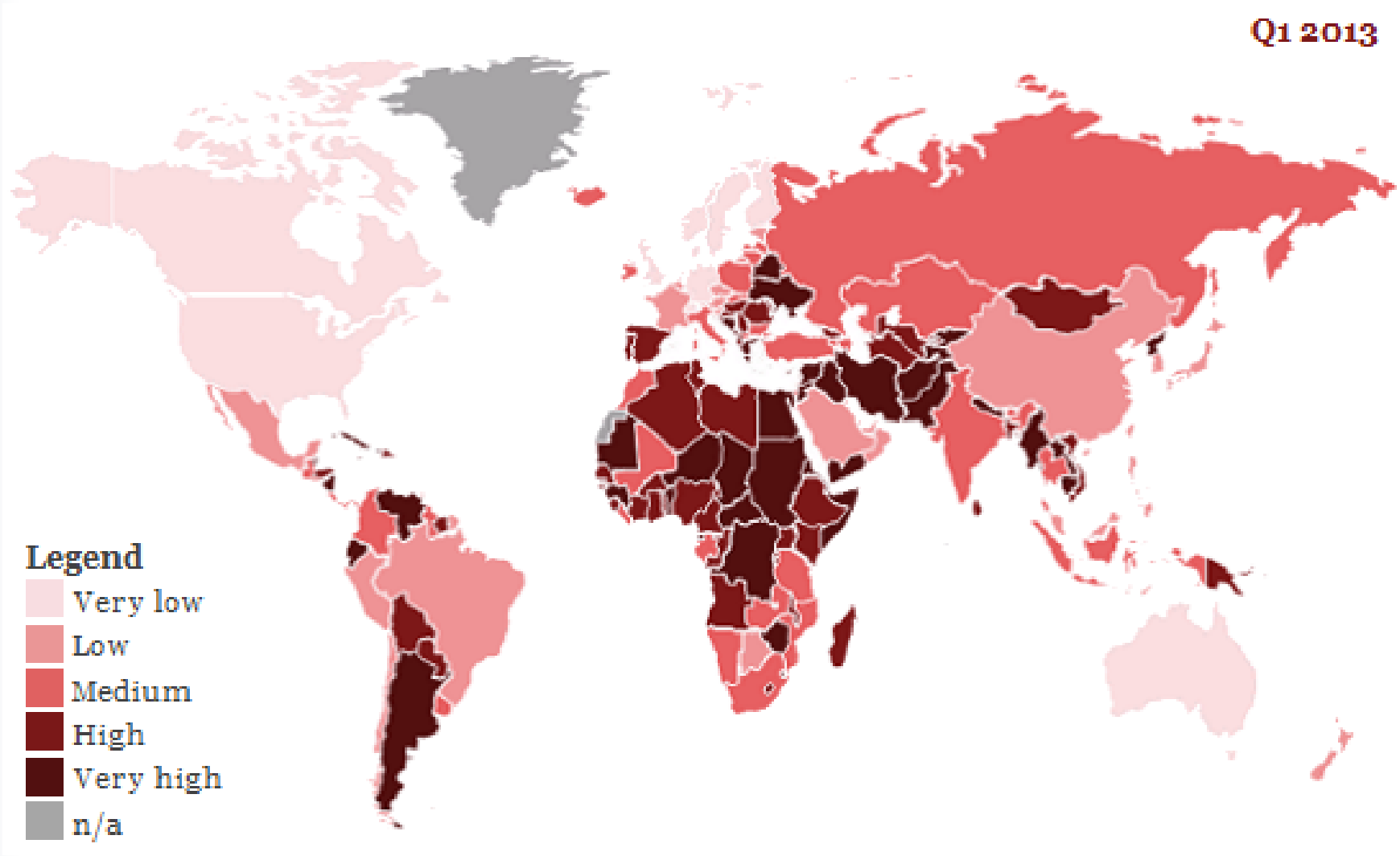
| Risk Adjusted Cash Flows | | NPV | Uncertainty | Risk | Schedule | RANPV |
|---|---|---|---|---|---|---|
| | | 5.0% | | | 1 | |
| Concentrate Net Smelter Return | | 1,810.3 | 0.95 | 0.95 | 0.95 | 1,556.0 |
| Dore Net Revenue | | 740.7 | 0.97 | 0.97 | 0.95 | 663.7 |
| Revenue | | 2,551.0 | | | | 2,219.7 |
| Operating Costs | | -587.7 | 1.05 | 1.02 | 0.95 | -599.4 |
| NSR Royalty | | -38.3 | 1.00 | 1.00 | 1.00 | -38.3 |
| Operating Cash Flow | | 1,925.1 | | | | 1,582.0 |
| Capital - Initial | | -832.9 | 1.10 | 1.50 | 1.03 | -1,408.6 |
| Capital - Sustaining | | -39.3 | 1.05 | 1.10 | 0.95 | -43.3 |
| Capital - Decommissioning | | -4.3 | 1.05 | 1.25 | 0.95 | -5.4 |
| Change in Working Capital | | 0.0 | 1.00 | 1.00 | 0.95 | 0.0 |
| Cash Flow Before Taxes | | 1,048.5 | | | | 124.7 |
| Income & Mining Tax | 50.3% | -527.0 | 1.00 | 1.00 | 1.15 | -72.1 |
| Total Cash Flow | | 521.4 | | | | 52.6 |





# Country Risk





# Risk Adjusted Net Present Values
# What Discount Rate To Use?

- What is right discount rate to use?

- Suggest using the corporate WACC as the reference discount rate for RANPV
  - WACC is the rate for the company's operations, it is the closest thing to the company's sense of "risk free".
  - WACC is the same starting point as the RADR calculation.
  - WACC is the reference hurdle rate for any risk adjusted evaluation:
    - RANPV ≥ zero meets the corporate WACC
    - RANPV < zeros does not meet the corporate WACC





# Risk Adjusting Cash Flows
# Concerns With Risk At Source



At this point in time, there is a major problem with presenting an evaluation wherein the risks have been fully represented in the cash flow:

- The results will look worse than competing projects that do not do this
  - With costs for risk included in the cash flows, DCF metrics will drop.
  - IRR will be lower
  - NPV will be lower at traditional discount rates
- People won't understand the results from a risk adjusted NPV
  - At this point there is no experience to which to compare the results
  - A whole new set of experience will have to be developed.
  - Management will not understand the lower hurdle rates
  - There will be a lot of explaining to management ... and shareholders.
- How do we get a measure of the true, fully risked cost factors when we have effectively institutionalized the system for not acknowledging or including them ("Value Engineering").
- People don't like change.