Managing capital risk exposure by design

CIM Montreal Branch and
the CIM Management and Economics Society

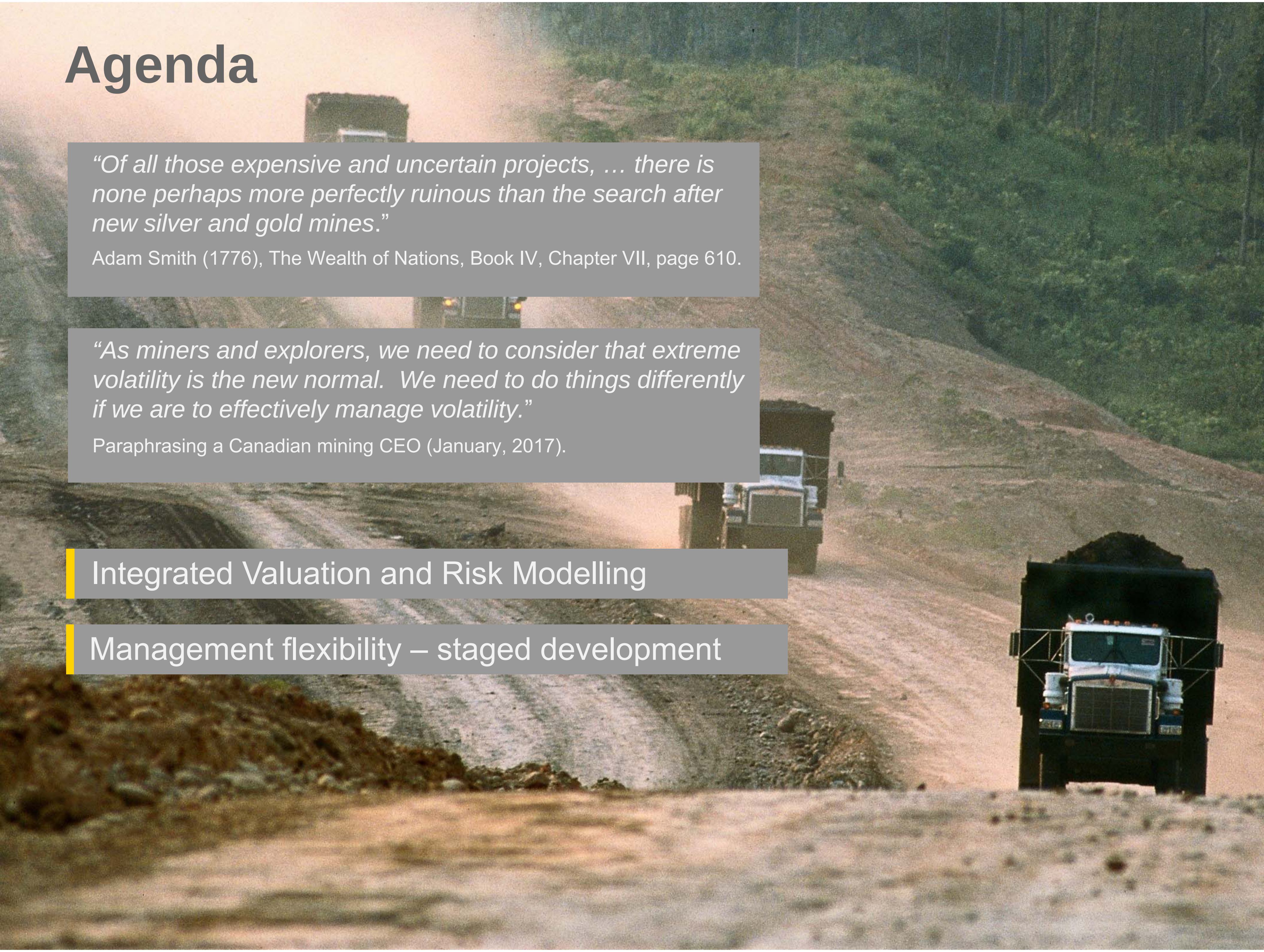
Dinner Conference

Michael Samis, Ernst &Young LLP

September 20, 2017

Building a better working world

Agenda



> *"Of all those expensive and uncertain projects, … there is none perhaps more perfectly ruinous than the search after new silver and gold mines."*
>
> Adam Smith (1776), The Wealth of Nations, Book IV, Chapter VII, page 610.

> *"As miners and explorers, we need to consider that extreme volatility is the new normal. We need to do things differently if we are to effectively manage volatility."*
>
> Paraphrasing a Canadian mining CEO (January, 2017).

- Integrated Valuation and Risk Modelling
- Management flexibility – staged development

Strategic capital management (SCM) —
Managing capital in support of business objectives

Protecting the balance sheet:
How to ensure company resilience?

Responsive operations
Improved risk monitoring
Adaptable capital structure

Optimizing the corporate portfolio:
How is portfolio performance maximized?

Focused performance metrics
Capture synergies
Systematic portfolio reviews

Investing capital:
Which assets support strategy?

Acquisition readiness
Structure creatively
Leading design / analytical practice

Raising capital:
Is capital structure aligned with strategy?

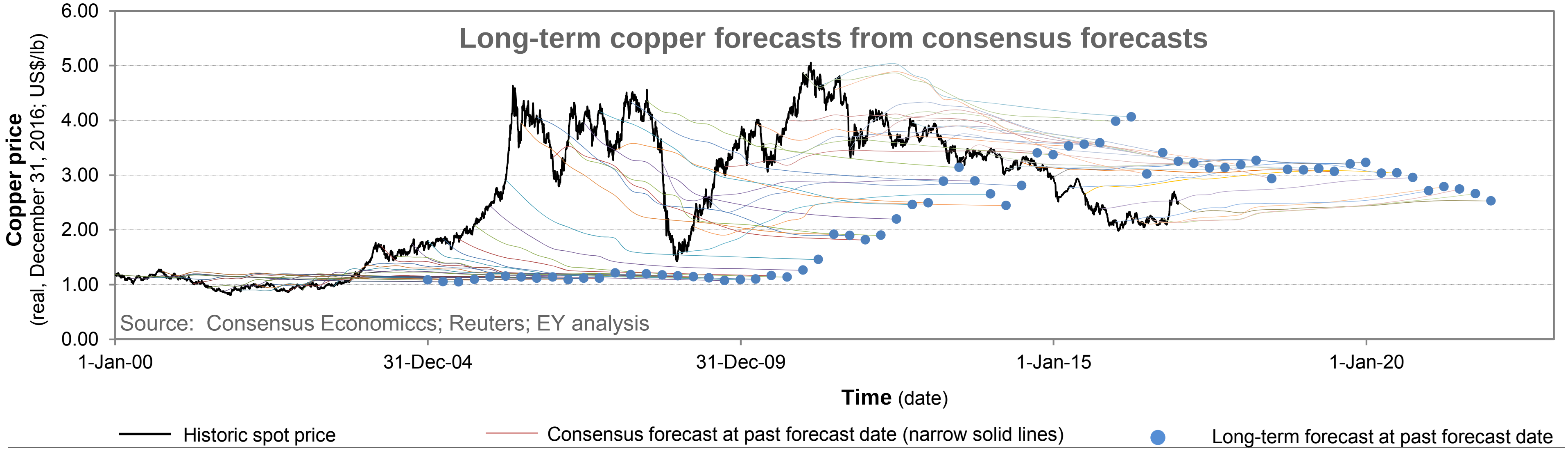
Divestiture readiness
Innovative finance

Two questions for SCM professionals

1. Are we missing relevant insights by relying on static cash flow models?
2. Can we better understand the risk + reward trade-offs of capital management decisions with dynamic cash flow models?

Strategic capital management —
Recognizing corporate forecast uncertainty

- SCM analysis is often performed with static forecasts that are updated annually for changes in business outlook.
  - Commodity price forecasts may be generated using a combination of industry marginal cost analysis, supply-demand studies, consensus forecasts and financial market information.
- Effectively describing uncertainty in corporate forecasts requires asking:
  - How do spot prices and other variables move around our forecasts?
  - How are corporate forecasts revised / updated as business conditions change?

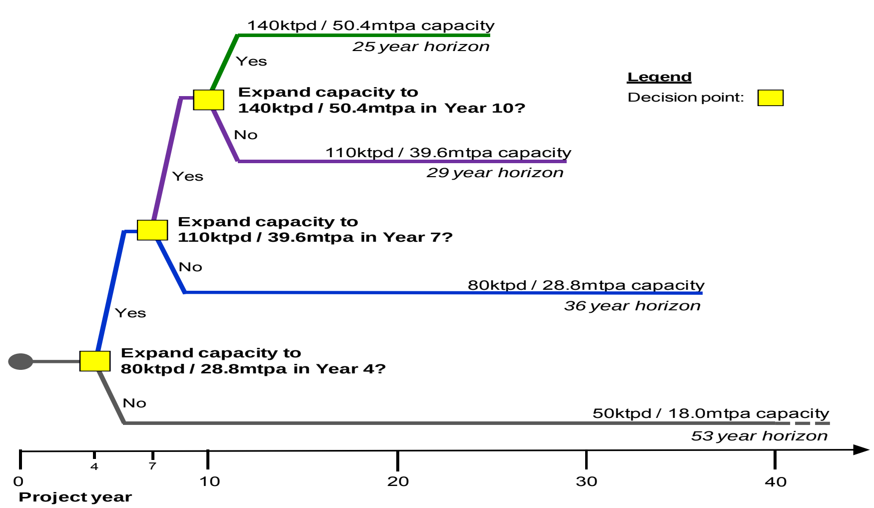


EY

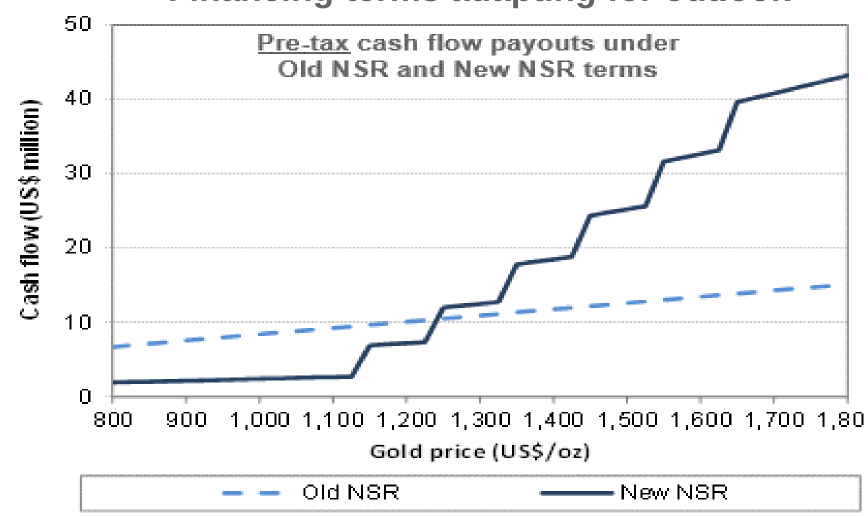
Strategic capital management —
Managing uncertainty with flexibility and contingent finance

- Static SCM analysis also ignores our ability to manage uncertainty through investment / operational flexibility and contingent finance.
- Modelling our ability to manage uncertainty requires thinking about:
  - Can we approach capital investment and operations such that we reduce the risks of sunk capital and efficiently adapt operations when the outlook changes?
  - Are there contingent finance possibilities that will improve capital investment efficiency and provide resilient financing structures?

Investment / operations adapting for outlook



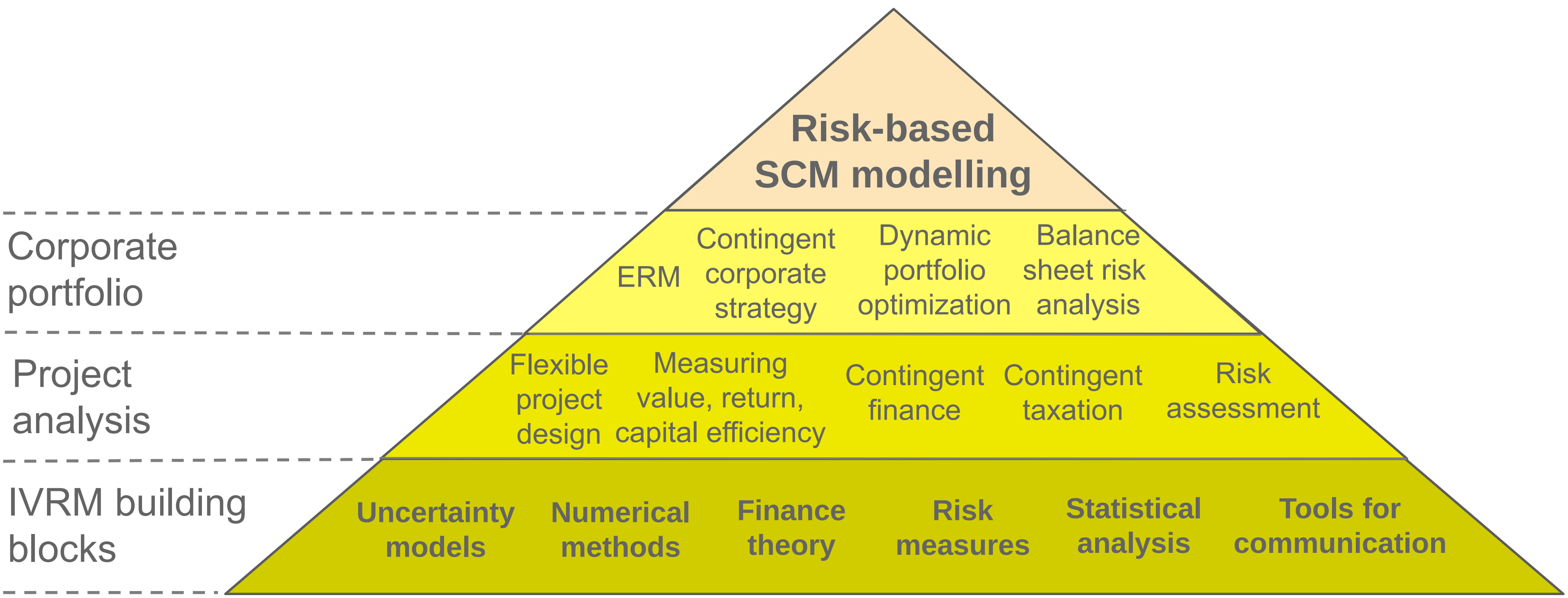
Financing terms adapting for outlook



EY

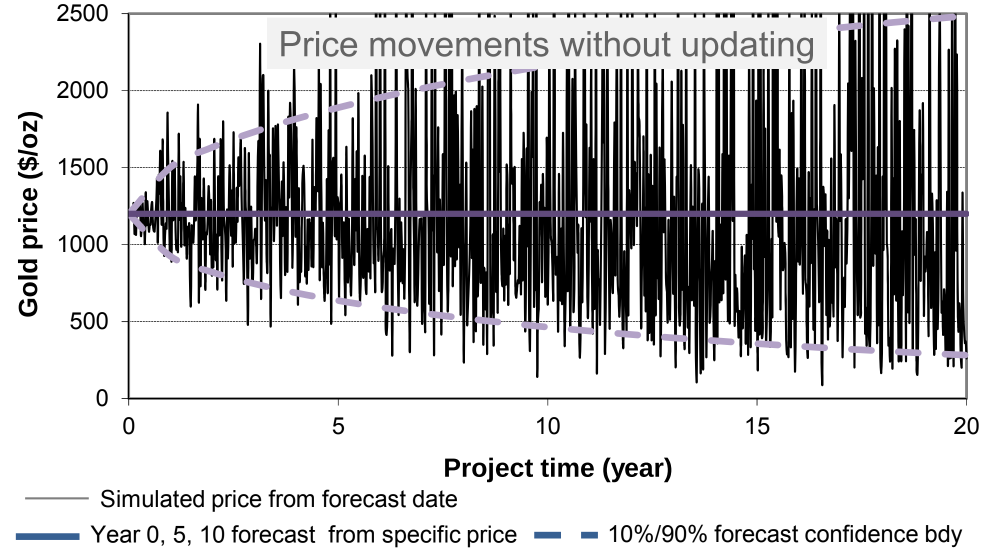
Integrated valuation and risk modelling
Creating a risk dimension for SCM analysis

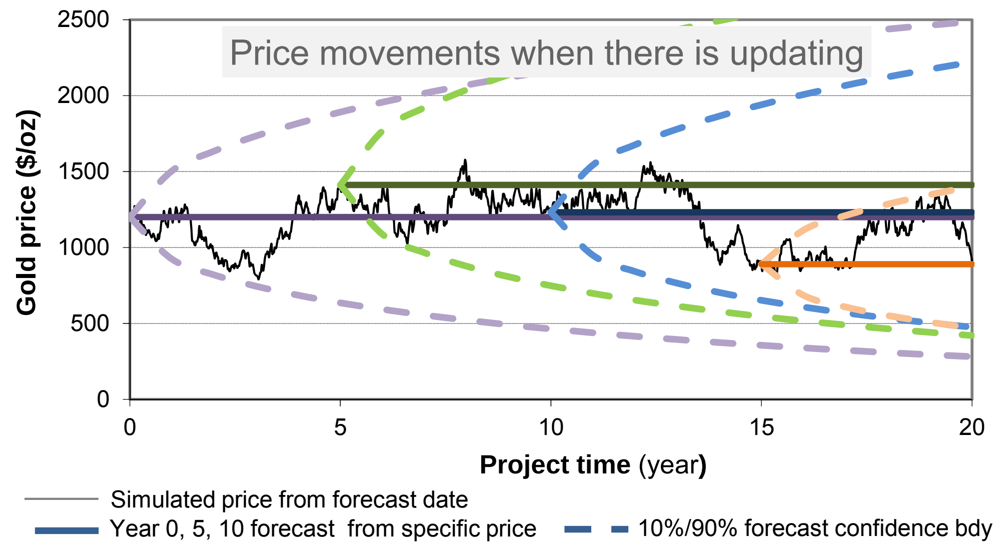
- **Integrated Valuation and Risk Modelling** (IVRM) provides a quantitative risk dimension to SCM analysis at both the project and corporate levels.
- IVRM building blocks combine ideas and techniques from:
  - Finance theory
  - Risk management
  - Numerical methods
  - Decision analytics
  - Statistical analysis
  - Communication



Some key features of IVRM —
Commodity price uncertainty described by stochastic processes

- Stochastic processes are used to describe commodity price and long-term forecasts behaviour in financial markets.
  - A stochastic process describes the possible changes of a variable through time – a set of uncertainty distributions indexed by time.
  - A key feature is updating future distributions (mean / associated variance) for recent price moves.
- Graphs on the right compare non-updating vs updating price models.
  - There is no forecast updating in the upper graph.
  - Which price path better reflects price moves in financial markets?



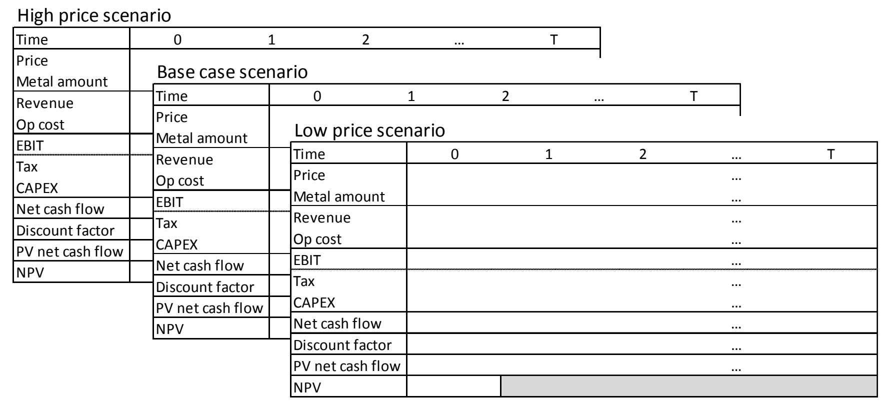


EY

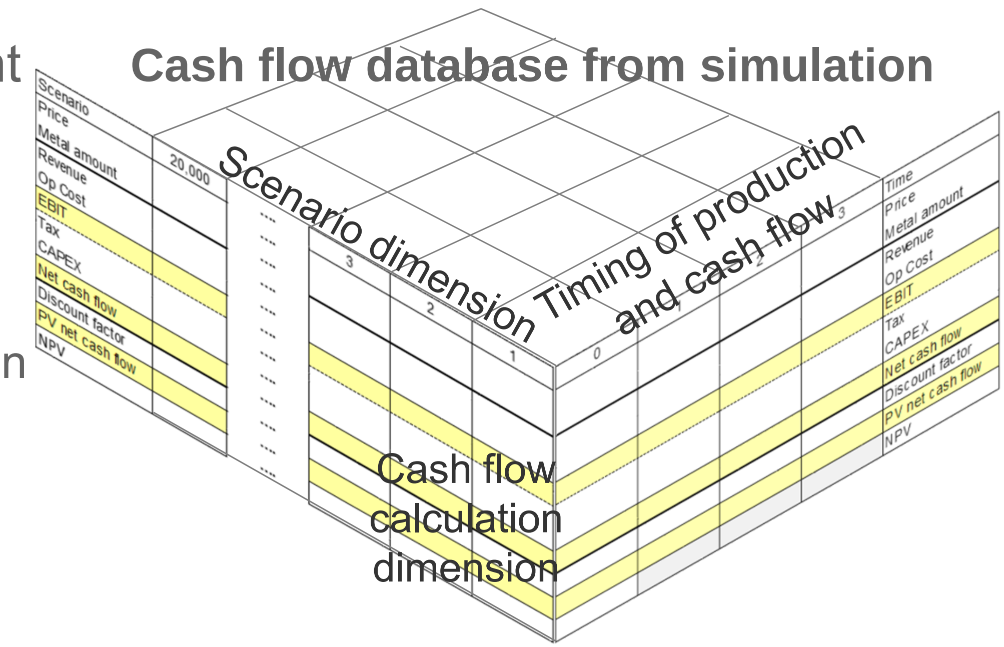
Some key features of IVRM —
Ability to consider a much larger number of cash flow scenarios

- Scenario analysis is often used in mining to assess investment risk.
  - Scenarios are often selected in qualitative manner.
- IVRM uses numerical methods to generate a very large number of scenarios for specific uncertainties (e.g. price) that are consistent with assumed behaviour (e.g. consistent with price movements in markets).
  - For example, simulation can generate a large number of cash flow scenarios.
  - This information can be used to gain insights about cash flow in various business environments.

Cash flow scenario analysis



Cash flow database from simulation



EY

Some key features of IVRM —
Expanded ability to communicate investment benefits and risk

Static cash flow model

Investment benefits summarized by…

Net present value
Profitability index
IRR
Payback period

Risk exposure assessed by…

Sensitivity analysis

Analysis communicated with…

Summary statistics
Spider diagrams
Expected CF graphs

IVRM with dynamic cash flow

Investment benefits summarized by…

Net present value
Profitability index
Modified IRR
Payback period

Risk exposure assessed by…

Sensitivity analysis
Event probabilities
Conditional expectations
Uncertainty measures
Loss thresholds

Analysis communicated with…

Summary statistics
Spider diagrams
Expected CF graphs
Confidence bdys
Decision trees
Decision boundaries
Histograms

Integrated valuation and risk modelling —
The IVRM value proposition for SCM

- IVRM helps **generate** and **communicate** SCM insights and provides **support** for decision-making. It is not:
  - A ploy to calculate a higher investment NPV for a favoured but challenged project.
  - A substitute for extensive industry experience.

- Supports **understanding** of key project, company, and market factors that influence **value** and **risk** which are not visible with static SCM analysis.
- Provides an excellent means of **communicating** investment uncertainty characteristics and their impact on **value** and **corporate risk exposure.**
- **Promotes SCM conversations that you may not have had before.**

Better understanding of your investment, more informed SCM decision making.

EY

Management flexibility – staged development

Example: Managing capital investment risk
Background

Issue:

A mining company is considering three design alternatives for a gold project with similar NPVs but different upfront CAPEX. How do you choose between the designs?

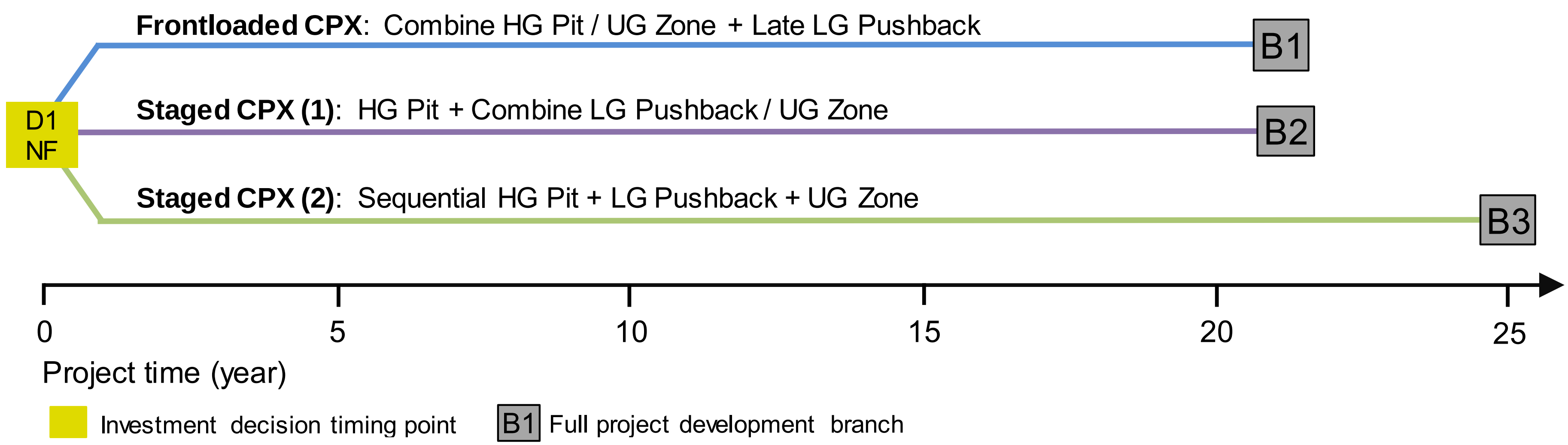
Solution:

Compare the three designs based on capital risk exposure and development flexibility. Generate risk and policy information by simulating metal prices and linking results to design features.

- A mining company (“MinCo”) is studying the development of a gold project with a high-grade open pit (“HG Pit”), a low-grade pushback (“LG Pushback” or “LGP”) and an underground extension (“UG Zone”).
  - A combined resource of 112.4 million tonnes containing a payable 6.5 million ozs.
- Three design alternatives are being studied with a maximum mill capacity of 18,000 tpd. Each design has a unique capital investment pattern ranging from frontloaded investment to a staged investment profile.
  - Total lifetime capital expenditure is $1,225 million for all designs.
- There is no clear choice as the three designs have seemingly similar NPVs with a long-term gold forecast of $1,200/oz.

Example: Managing capital investment risk
Three development alternatives

- Standard investment analysis considers each design alternative separately.
  - **Frontloaded CPX**: Develop HG Pit and UG Zone together for $1,125 million. ROM capacity is 18ktpd. Develop LG Pushback in Year 13 for $100 million. ROM capacity for LG Pushback is 18ktpd. Mine life is 21 years.
  - **Staged CPX (1)**: Develop HG Pit for $775 million. ROM capacity is 18ktpd. Combine LG Pushback and UG Zone development in Year 10 for $450 million. ROM capacity for Combined LG Pushback and UG Zone is 18ktpd. Mine life is 21 years.
  - **Staged CPX (2)**: Develop HG Pit for $775 million. ROM capacity is 18ktpd. Develop LG Pushback in Year 10 for $100 million. ROM capacity is 18ktpd. UG Zone developed in Year 16 for $350 million. ROM capacity for LG Pushback is 7ktpd. Mine life is 25 years.



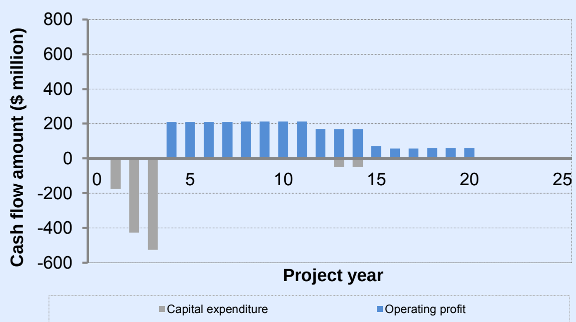
EY

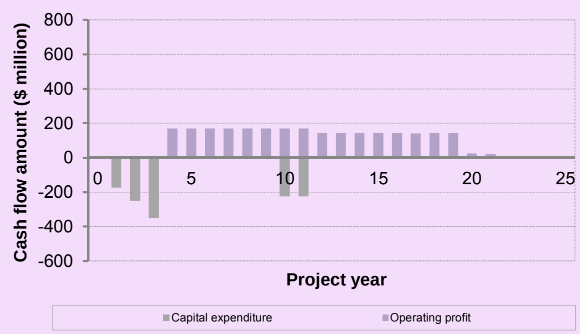
Example: Managing capital investment risk
Cash flow information for the three design alternatives

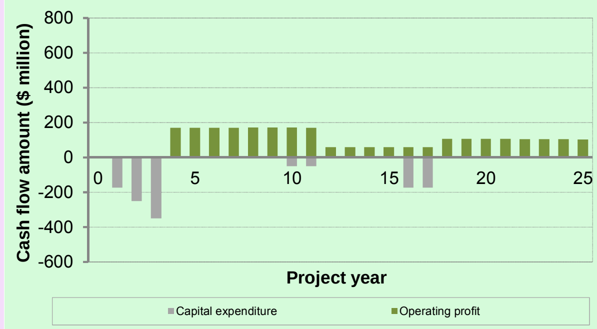
- The cash flow information generated by a static cash flow model is limited.
  - Amount and timing of cash flow is provided but risk is communicated with simple measures linked to sensitivity analysis.
  - Risk measures difficult to generate with a static cash flow model.

	Frontloaded CPX	Staged CPX (1)	Staged CPX (2)

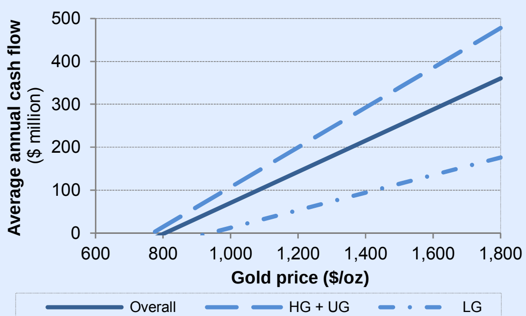
Net cash flow and capital profile

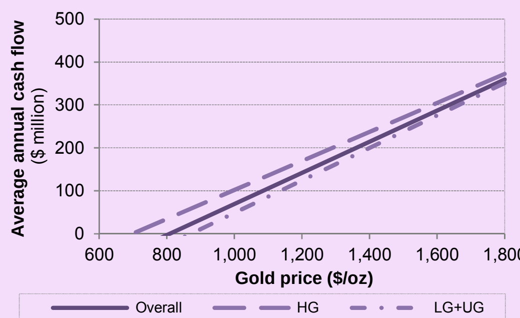


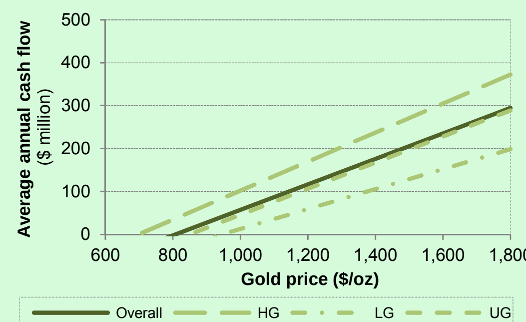




Cash flow risk





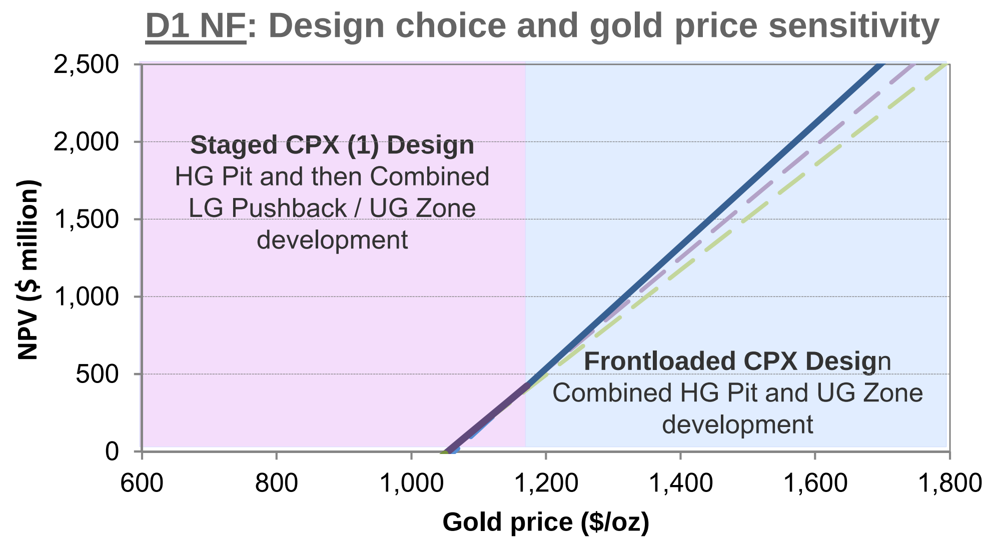


EY

Example: Managing capital investment risk
Standard investment analysis with static cash flow

- Conventional cash flow analysis suggests the **Frontloaded CPX** design generates the most value.
  - Capital investment efficiency of the **Staged CPX (1)** design is slightly higher (7.5%) reflecting delayed capital expenditure
- **Frontloaded CPX** design is preferred for the project when gold prices are above $1,170/oz. The **Staged CPX (1)** design is preferred at prices below this point.
- All designs appear to have similar sensitivity to changes in gold price.

Design alternative	Investment benefit	
	NPV(5%) ($ million)	Profitability index
Frontloaded CPX	**535**	0.511
Staged CPX (1)	526	**0.549**
Staged CPX (2)	495	0.545

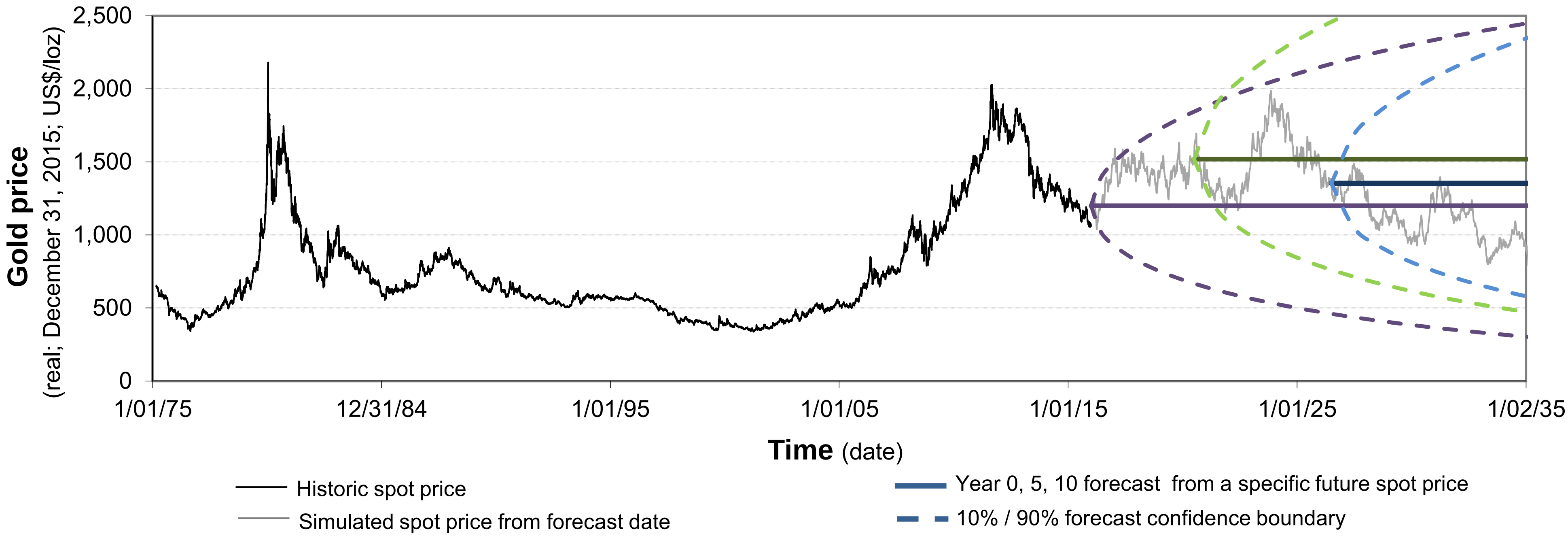


EY

Example: Managing capital investment risk

Introducing gold price uncertainty

- Gold price uncertainty is modelled with a non-reverting distribution with an initial long-term forecast of $1,200/oz.
- Key features include:
  - Long-term forecasts move in lockstep with spot price movements. A 2% rise in the spot price results in a 2% increase in the long-term forecast price.
  - Uncertainty increases with term (time from today).

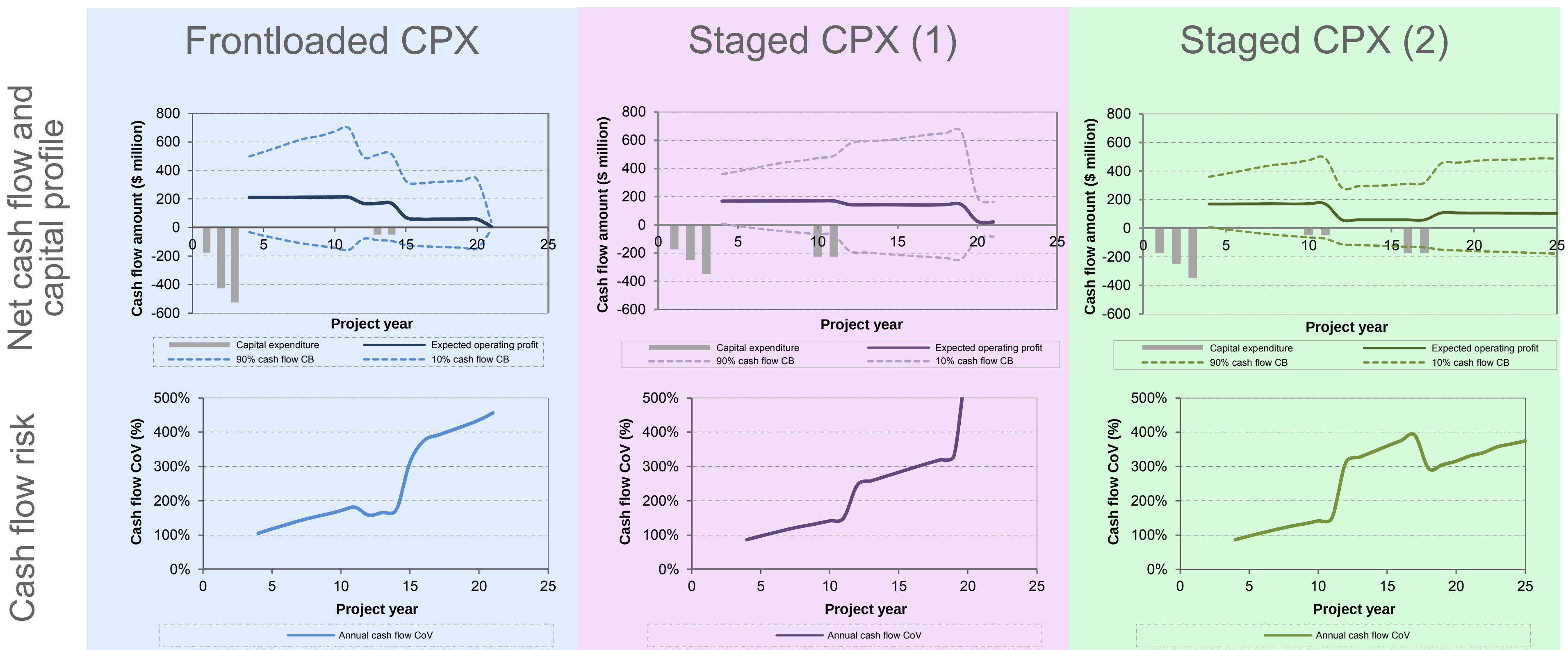


EY

Example: Managing capital investment risk

Cash flow information for the three design alternatives

- The introduction of a gold price uncertainty model provides a greater range of cash flow information.
  - Cash flow amounts are supplemented with a range of risk information such as cash flow variability and level of uncertainty.

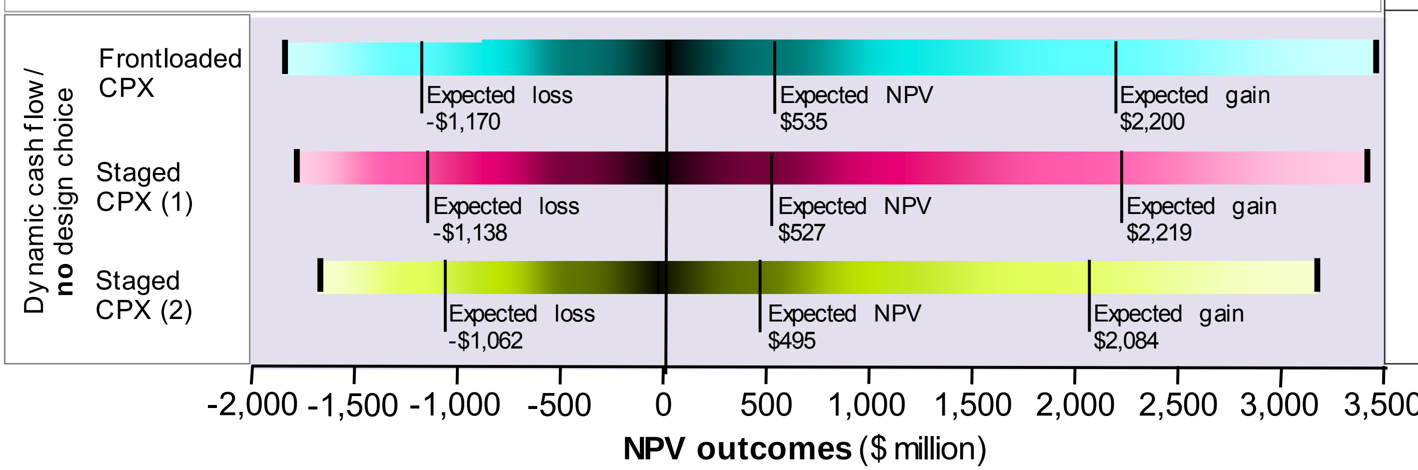


EY

Example: Managing capital investment risk
Investment benefits and risk exposure (no future design choice)

- Investment benefits are unaffected by modelling gold price uncertainty.
  - Other projects may have different static and dynamic NPVs from non-linearities.
- Risk information from simulation suggests project designs are risky.
  - Conditional profitability index (PI) losses are high. Expect to lose $1.10 for every $1.00 of capital invested if NPV negative.
  - Conditional NPV loss for each design is also high at $1.1 billion if NPV is negative.
- Risk levels seem excessive at this point in our analysis.

NPV / risk exposure map

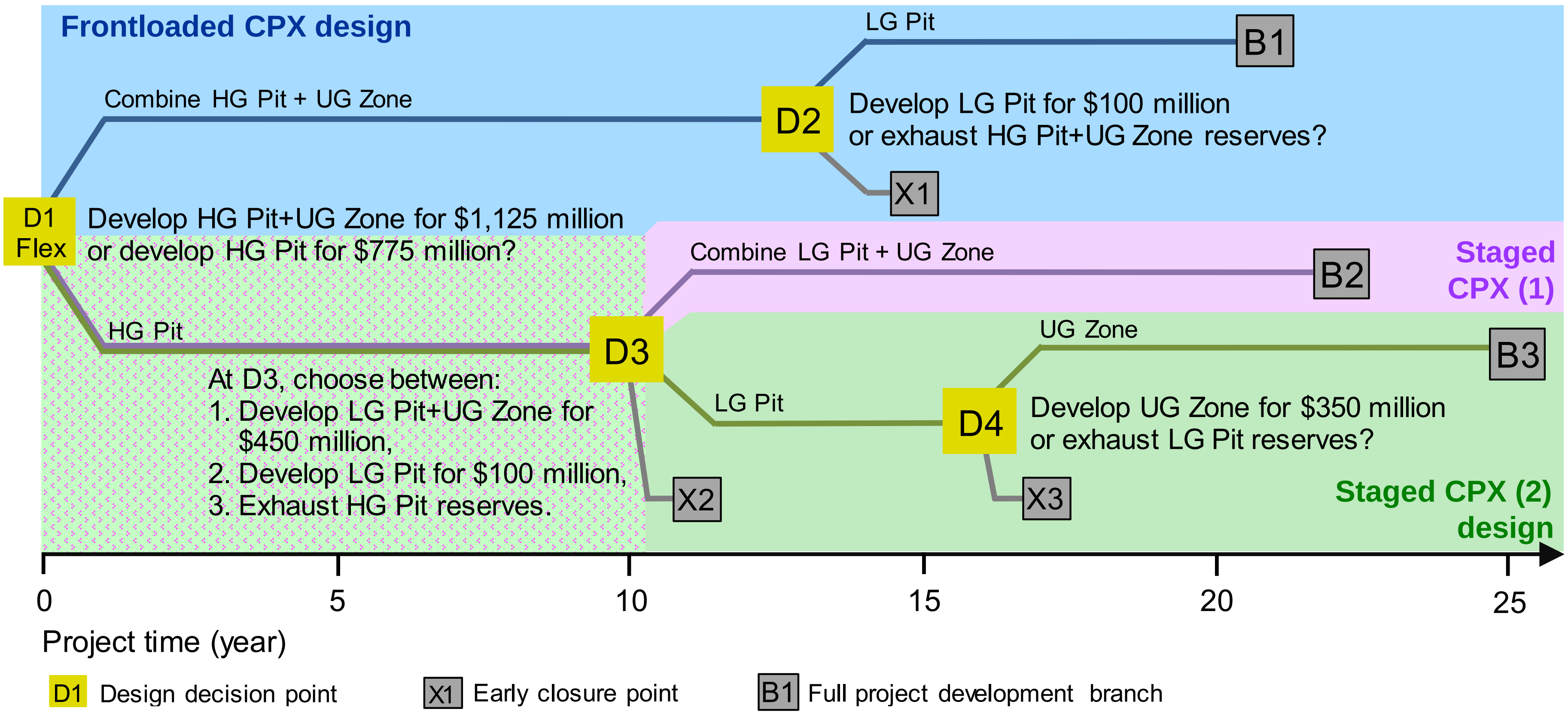


Profitability index (PI)	PI risk exposure	
	PI loss	PI gain
0.51	-1.14	2.07
0.55	-1.18	2.29
0.55	-1.16	2.29

Example: Managing capital investment risk

Representing design flexibility with a decision tree

- Future design flexibility can be reinterpreted as a decision tree which maps decision timing (yellow boxes) and project closure (grey boxes).
  - Multiple possible development paths are grouped into Frontloaded CPX and Staged CPX (1) & (2) designs.

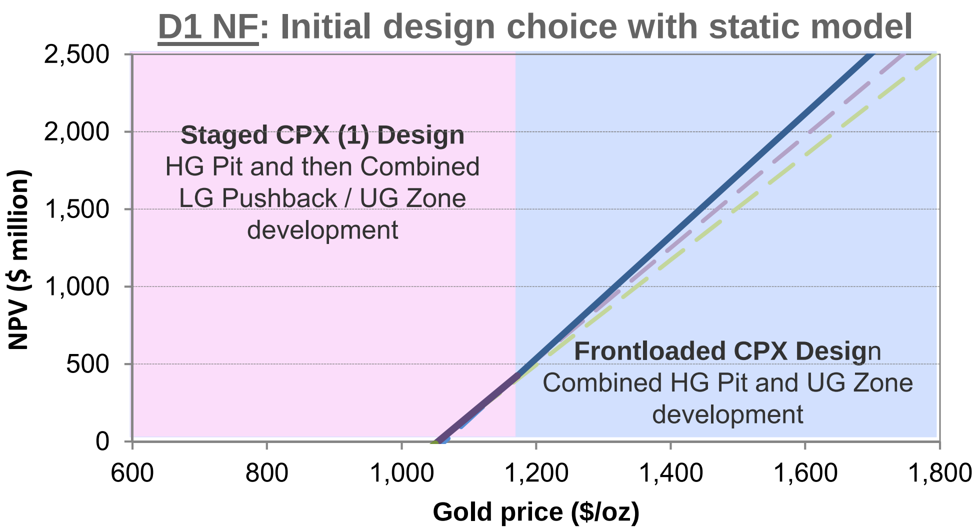


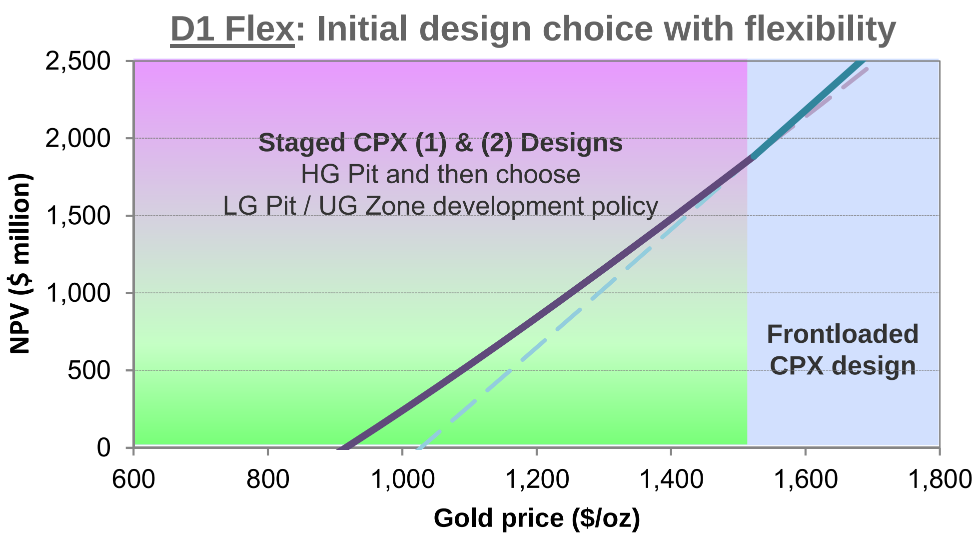
EY

Example: Managing capital investment risk

Future design flexibility also impacts the initial investment decision

- Recognizing future design flexibility can alter your initial investment decision.
  - A static cash flow model suggests the **Frontloaded CPX** design is preferred when the Time 0 gold price is above $1,170/oz.
  - When future design flexibility is recognized, the **Frontloaded CPX** design is preferred only if the Time 0 gold price is above $1,525/oz.
- The presence of flexibility tends to delay investment – the preference here is to defer capital investment until later unless gold prices are high.





EY

Example: Managing capital investment risk
Design flexibility at future decision points

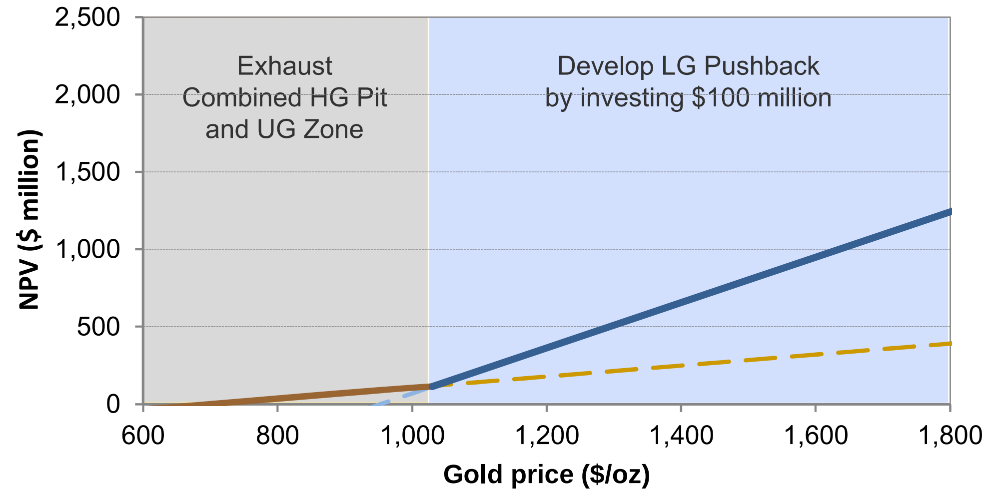
- Design flexibility allows investment risk to be managed.
- For **Frontloaded CPX**, the choice in Year 13 is whether to invest $100 million or close the mine early.

Gold price	Development action
Above $1,030	Develop LG Pushback
Below $1,030	Exhaust HG Pit + UG Zone

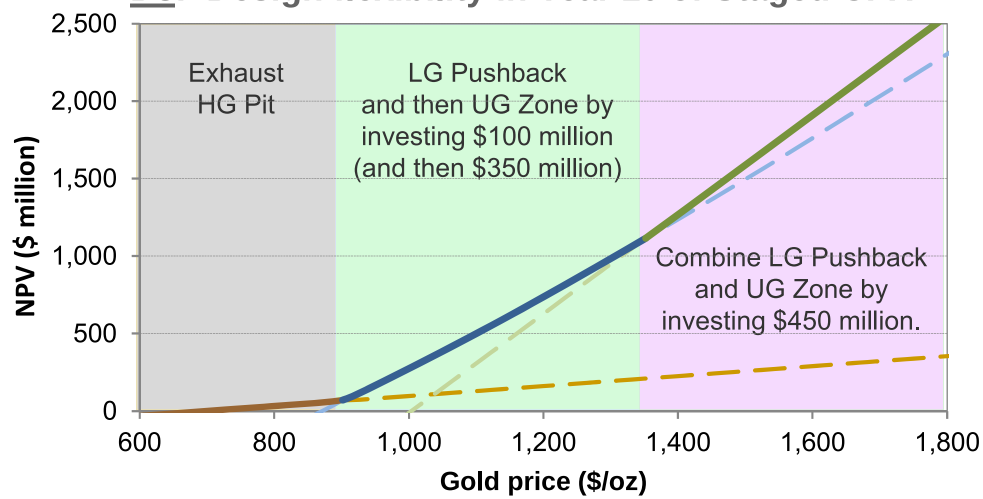
- For **Staged CPX (1) & (2)**, the choice in Year 10 is invest $450 million or $100 million or nothing (close early).

Gold price	Development action
Above $1,350	Combine LG Pushback and UG Zone
$900 - $1,350	LG Pushback then UG Zone
Below $900	Exhaust HG Pit

D2: Design flexibility in Year 13 of Frontloaded CPX



D3: Design flexibility in Year 10 of Staged CPX

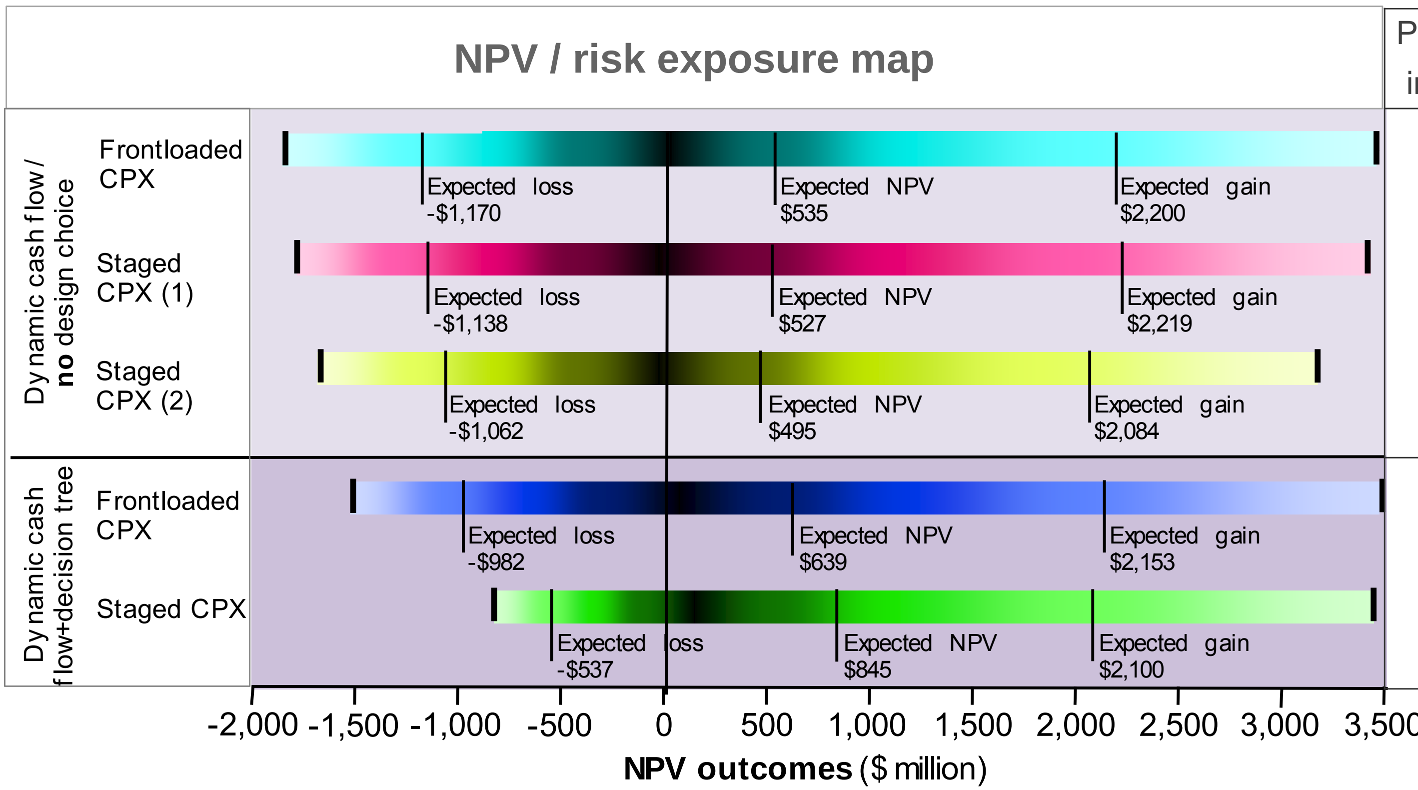


EY

Example: Managing capital investment risk

Investment benefit and the risk levels of flexible development

- Recognizing design flexibility provides the following analytic refinements:
  - Value increases by 60% (≈$500m to $850m) and capital efficiency increases by 50% (≈$0.55 to $0.81). Preferred design is now staged development.
  - Risk levels are much lower (about 50%) with staged development as capital only invested if business environment is favourable.



Profitability index (PI)	PI risk exposure	
	PI loss	PI gain
0.51	-1.10	2.07
0.55	-1.18	2.29
0.55	-1.16	2.29
0.60	-0.97	2.03
0.81	-0.76	2.21

EY

Example: Managing capital investment risk
Some thoughts to ponder…

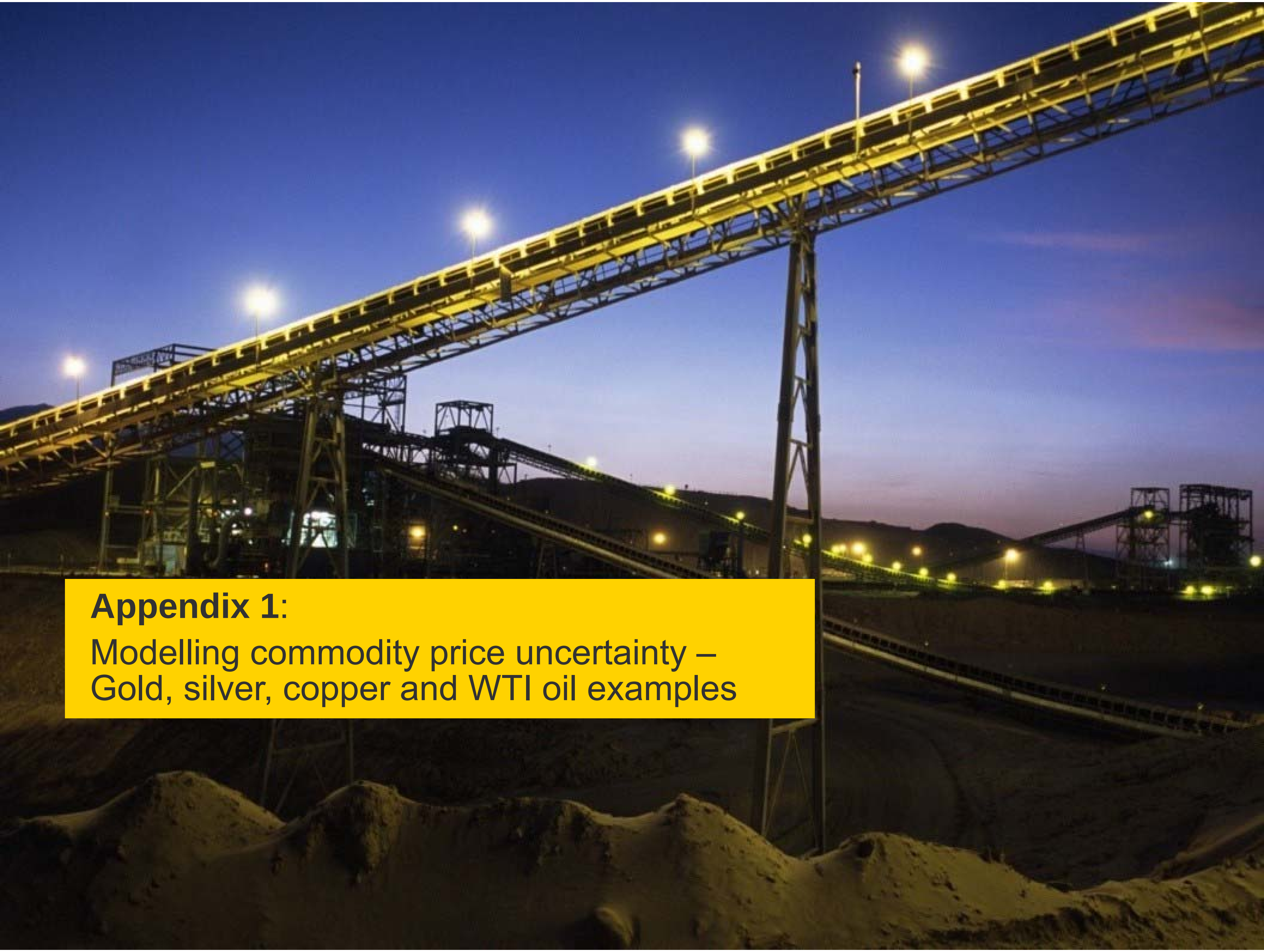
- This IVRM case study highlights the importance of recognizing uncertainty and its impact on design choices. In this instance, ignoring flexibility by using a static cash flow model to support the investment decision:

  Undervalues the ability to stage project development, which leads to…

  Front-loading of capital investment at $1,200/oz gold, which creates…

  Reduced investment efficiency and **needless capital risk** for your investors.

- There are a number of extensions to this example:
  - Cost uncertainty
  - Intermediate timing of the UG Zone
  - Capacity increases
  - Exploration planning
  - Geological uncertainty
  - Early closure
  - Satellite deposits
  - Project / corporate risk budgeting



Appendix 1:

Modelling commodity price uncertainty – Gold, silver, copper and WTI oil examples

Modelling commodity price uncertainty —
The importance of long-range forecasts

- Long-range metal price forecasts and the uncertainty around those forecasts are a key input into the analysis supporting natural resource SCM decisions.
  - Forecasts influence corporate strategy, project design, financing, taxation, community relations and government policy, among other things.
  - Price forecasts are generated with a range of techniques, incorporating insights and information from market participants and market analysts.
- Unfortunately, with static cash flow models and annual planning cycles, we often ignore how our SCM decisions are impacted by updates to our long-range forecasts over the planning cycle.

Modelling commodity price uncertainty —
Scenario analysis and long-range forecasts

- The natural resource industries often recognize long-range forecast price uncertainty with scenario analysis (price decks).
  - Long-range forecast scenarios are sometimes probability weighted to include the effects of price uncertainty in decision making and valuation. This approach to uncertainty modelling ignores long-term forecast updating.

Price deck	
Scenario	Au price
Blue sky	$1,500
Higher	$1,400
High	$1,300
Forecast	**$1,200**
Low	$1,100
Lower	$1,000
Lights out	$ 900

The uncertainty around the forecast may be taken into account by assigning probability weights to each scenario

Price deck		
Scenario	Au price	Probability
Blue sky	$1,500	5%
Higher	$1,400	10%
High	$1,300	20%
Forecast	**$1,200**	**30%**
Low	$1,100	20%
Lower	$1,000	10%
Lights out	$ 900	5%
Expected price		**$1,200**

EY

Modelling commodity price uncertainty —
Three components of an uncertainty model

- However, price decks and their associated probability-weights are an incomplete model of price uncertainty – we still need to recognize forecast updating over time.

Three features of a complete model of price uncertainty

Price variability describing uncertainty around a forecast

- The model we use generates a lognormal price distribution at each future time point.

Forecasts generated by:

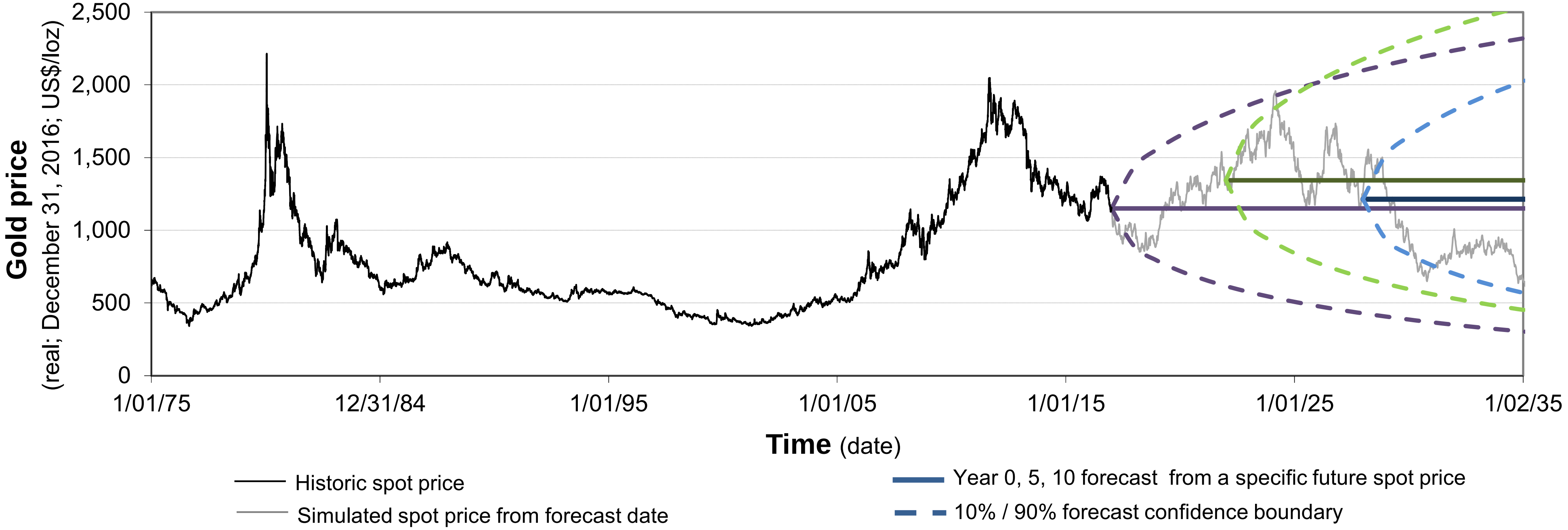
- Supply / demand projections.
- Cost curve models.
- Consensus forecasts.
- Financial market information.

Forecast updating allowing for dynamic expectations

- Future expectations change as future prices change.

Types of commodity price uncertainty models —
Single factor non-reverting models

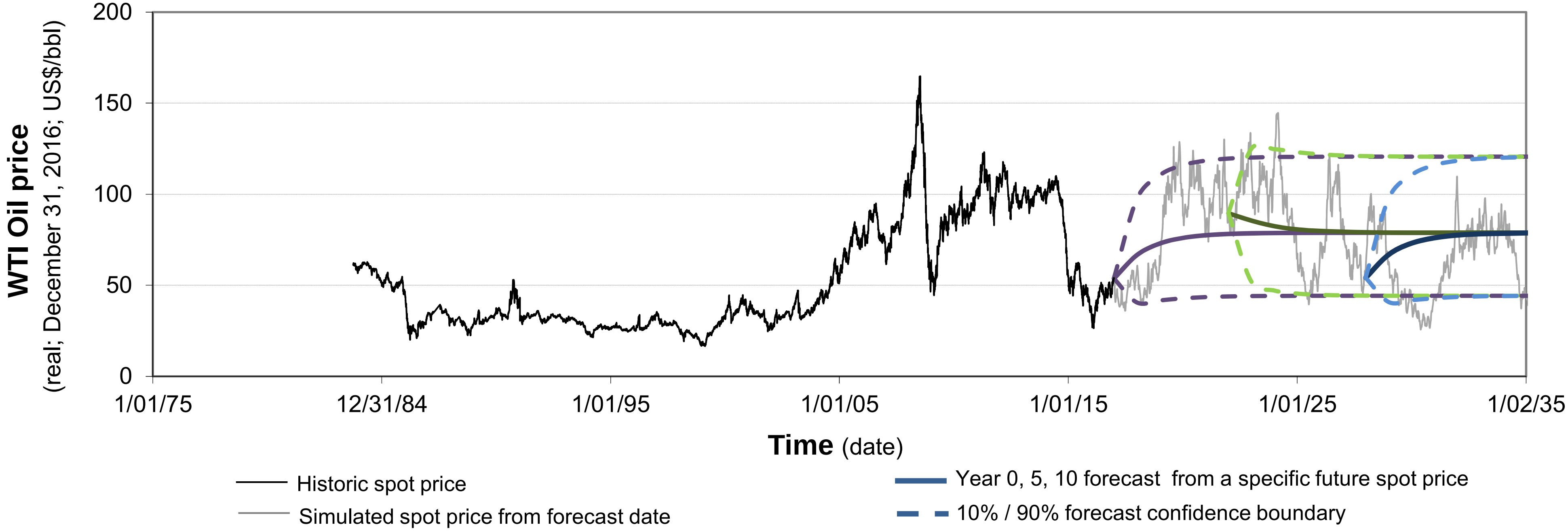
- Non-reverting models are used to describe the price movements of financial stocks, precious metals, FX and possibly a few base and minor metals.
  - Long-term forecasts move in lockstep with spot price movements. A 2% rise in the spot price results in a 2% increase in the long-term forecast price.
  - Uncertainty increases with term (time from today).
- **Limitation:** Applies only to financial stocks, precious metals and FX rates.



EY

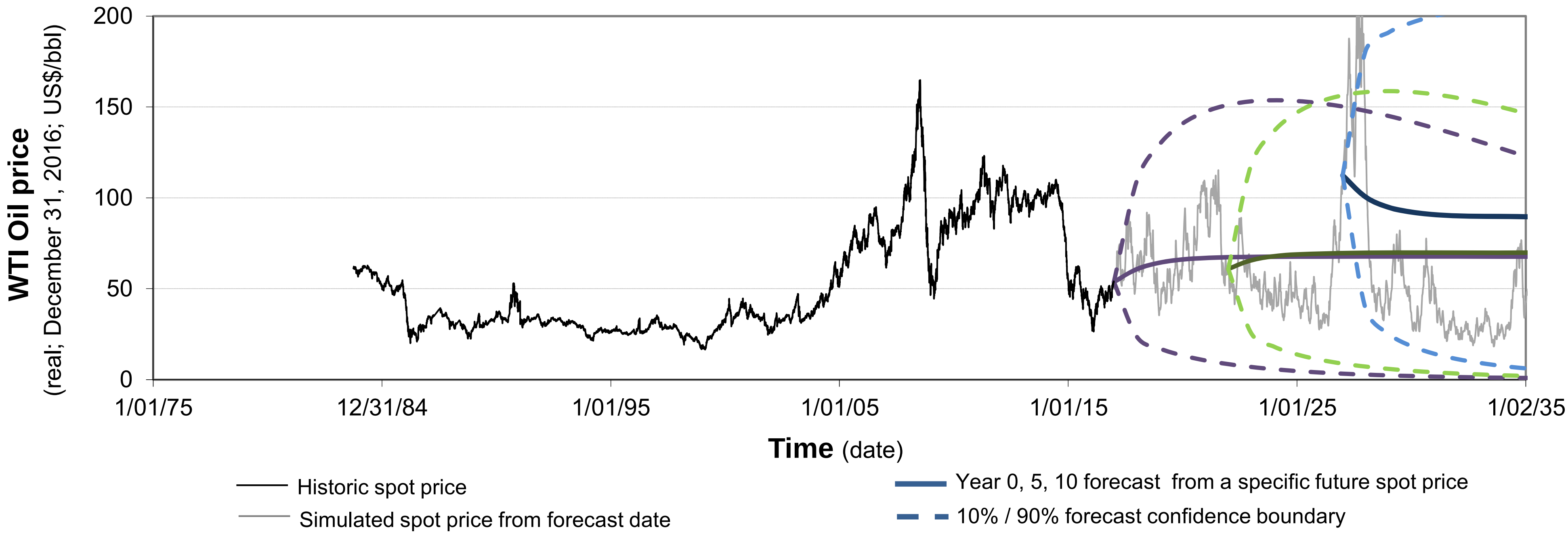
Types of commodity price uncertainty models — Single factor reverting models

- Reverting models describe base metal and energy price movements.
  - A constant real or nominal long-term forecast. Spot price varies around and reverts to the long-term forecast price.
  - Uncertainty saturates with term, reducing long-life project cash flow discounting.
  - Need to update the long-term forecast for market regime changes.
- **Limitation:** A single long-term forecast that does not change over time.



Types of commodity price uncertainty models — Two-factor models

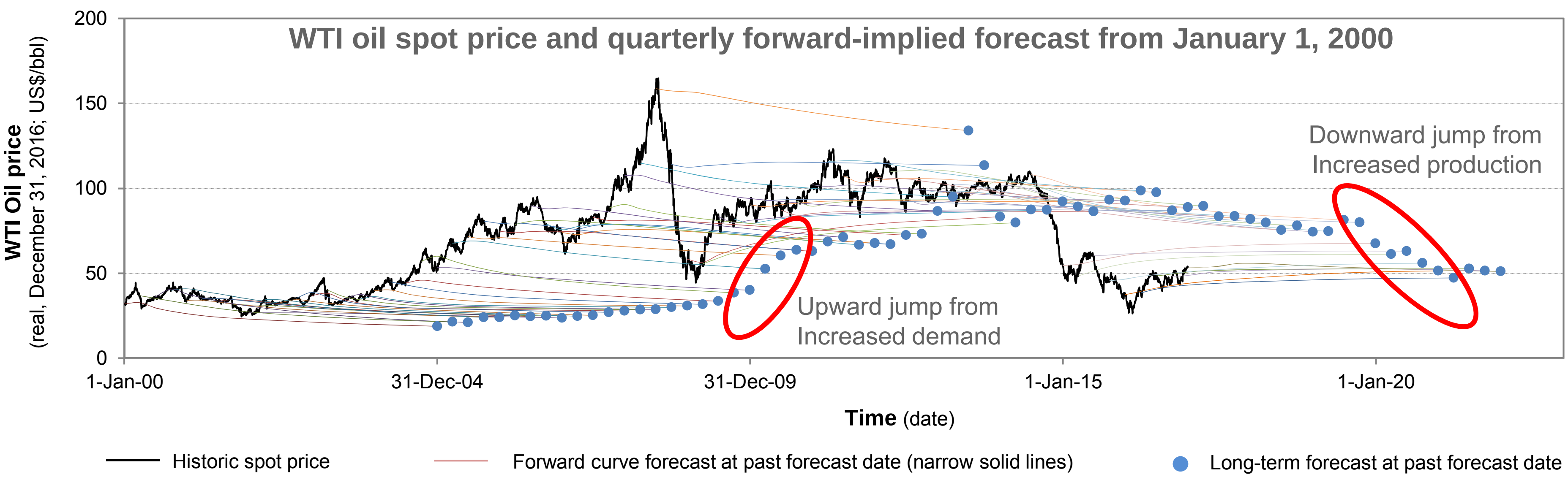
- Two-factor models better reflect base metal and energy price movements.
  - Both spot price and long-term forecast price are uncertain.
  - Uncertainty increases with term. Variability in the long-term forecast can generate option value for long-life base metal and energy projects.
- **Limitation:** Parameterization using historical prices results in uncertainty levels (indicated by confidence intervals) that are unreasonably high.



EY

Types of commodity price uncertainty models — Jumps / high volatility creating sudden market outlook changes

- Outlook for long-term prices can also change dramatically over short periods.
  - The increase in oil demand from China in 2003 had an impact on prices that was sudden, dramatic, and unexpected.
  - The decline in oil prices as a result of increased Saudi production was sudden, dramatic, and unexpected.
- These sudden price forecast changes are may be the result of price jumps or periods of high volatility They are random and can happen at any time.

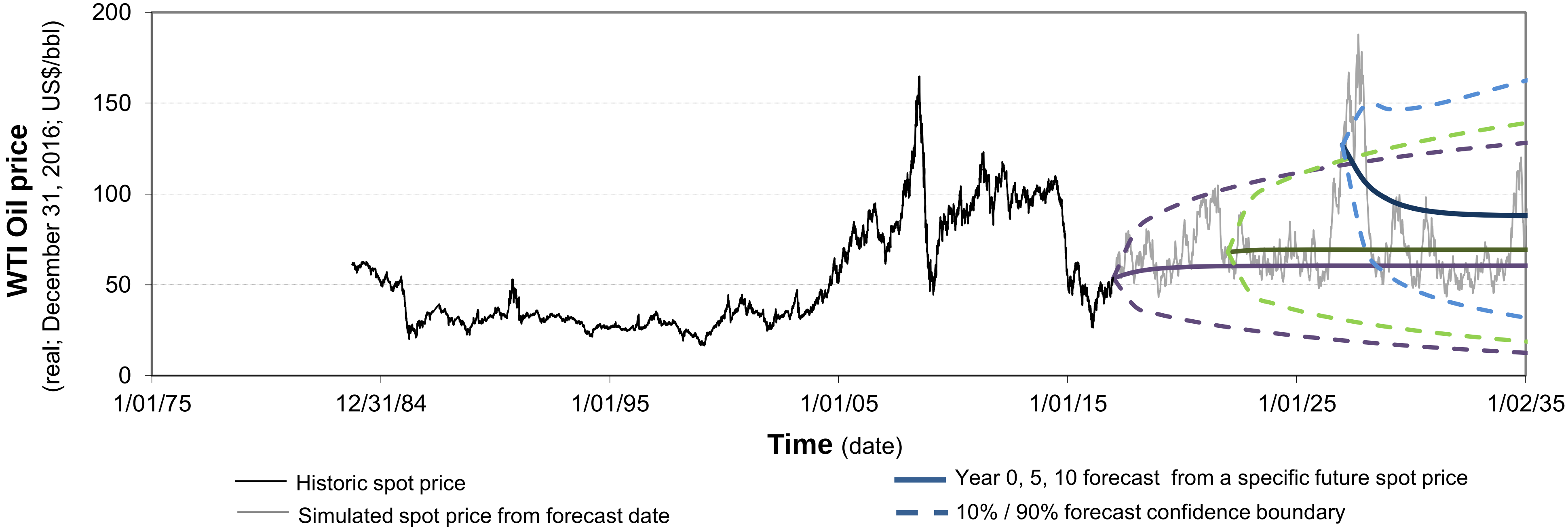


EY

Types of commodity price uncertainty models —
Two-factor model with jumps / high volatility

- Two-factor reverting models extended to include a jump factor for unexpected large changes in long-term forecast.
  - Jump factor absorbs some of the long-term forecast volatility.
  - Simulated price behavior may be closer to what we see in markets.

- **Limitation:** Increased complexity and simulation time.



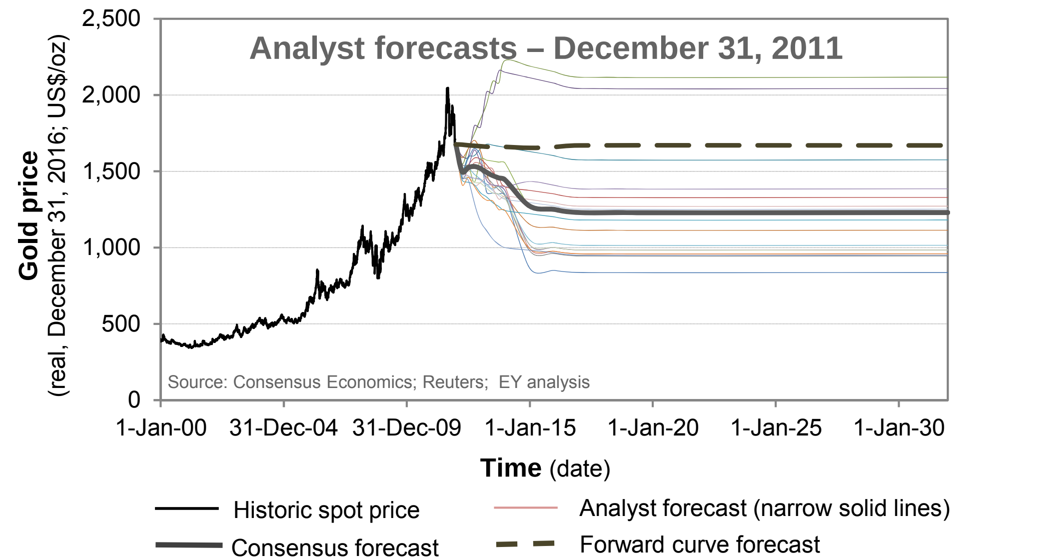
EY

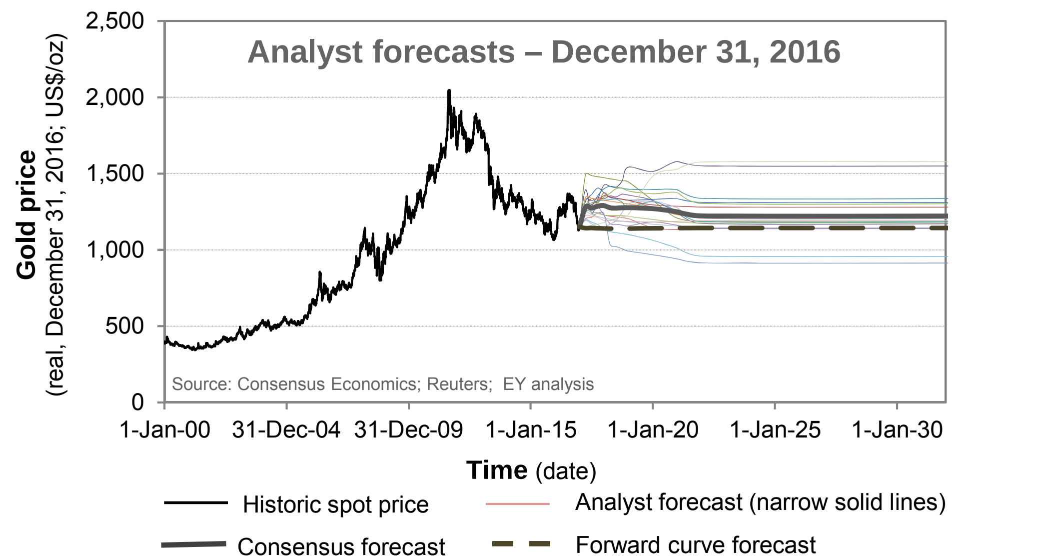
Gold price uncertainty model —
Analyst / consensus / forward long-term price forecasts

- Gold is primarily held as an investment asset with some industrial uses.
- Range of business outlooks at both dates. Analyst price forecasts more divergent 5 years ago.

Forecast date	Long-term forecast price ($/oz; 30/12/16)			
	Analyst		Calculated / market	
	Low	High	Consensus	Forward
31-Dec-11	837	2,117	1,230	1,670
31-Dec-16	915	1,576	1,222	1,143

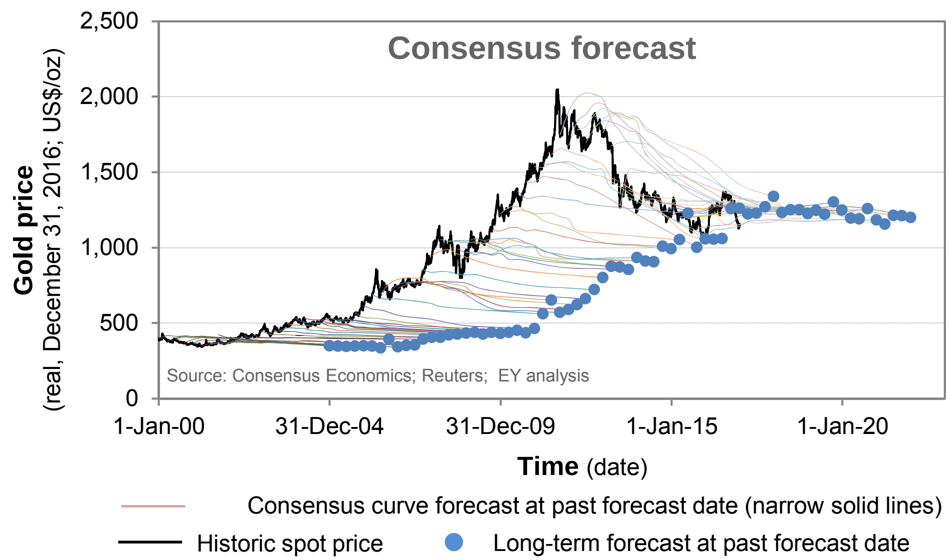
- Forward market long-term forecast had greater change over 5 years than consensus long-term forecast.

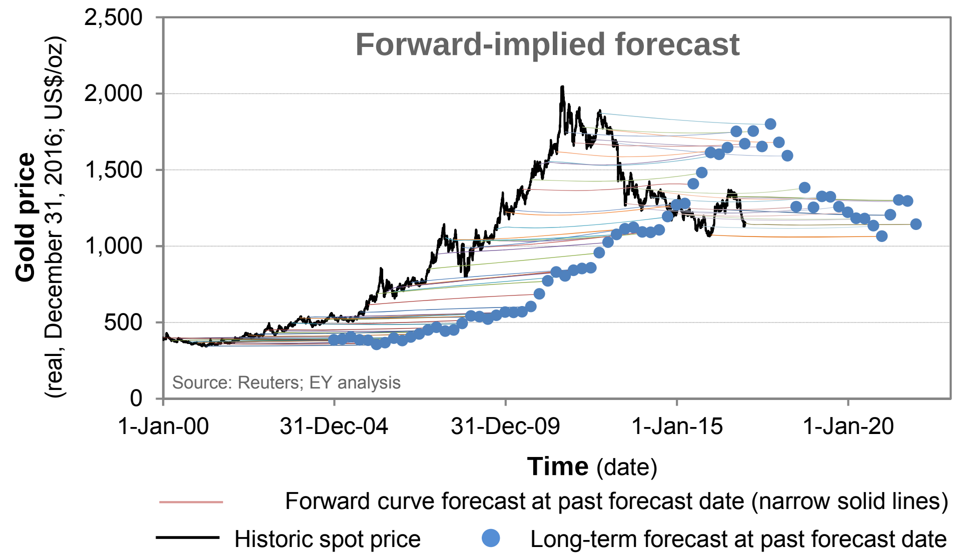




Gold price uncertainty model —
Price behavior and forecast updating

- Consensus forecasts display anchoring – forecast updates are less reactive to spot market movements than forward-implied forecast.
- Forward-implied forecasts respond quickly to market movements as long-term estimates move upwards and downwards in a parallel fashion.
- Analyst forecasts provide information by non-market participants, and so have limitations compared with the actual financial trades embedded in forward contracts.

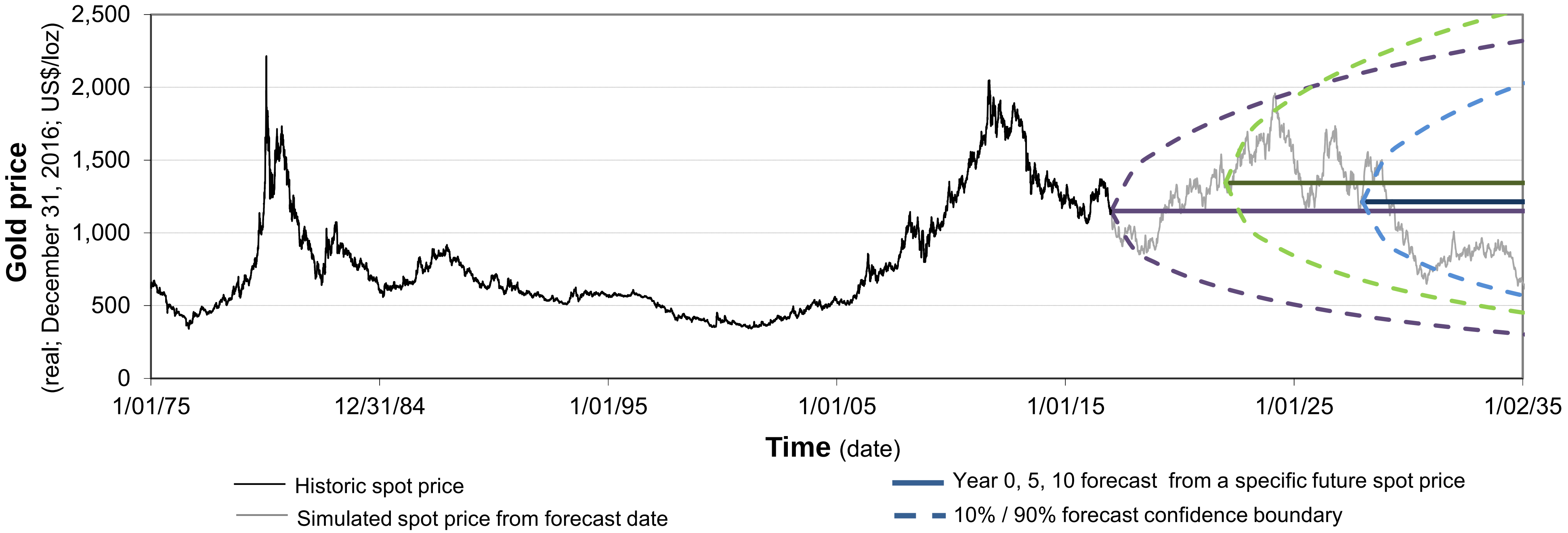




EY

Gold price uncertainty model —
Simulated prices with one factor NREV uncertainty model

- Gold prices are modelled as a non-reverting process around an updating long-term forecast. Consistent with gold being a store of perceived value.
  - Volatility is estimated to be 19% using price data since 1974.
  - No statistical evidence of reversion (unlike analyst forecasts).
  - The stochastic model here assumes a flat forecast in real dollars at each date. The model can have upward or downward trending forecasts at each date.



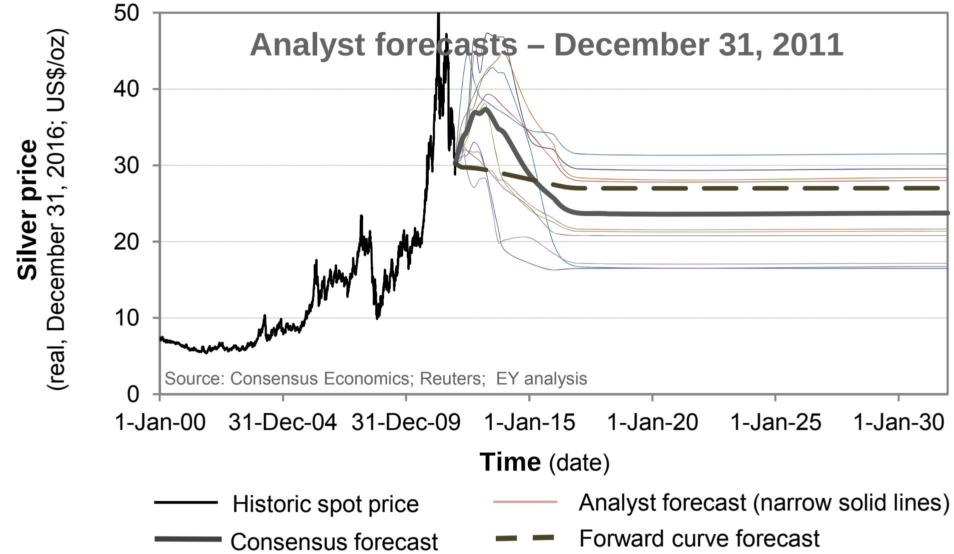
EY

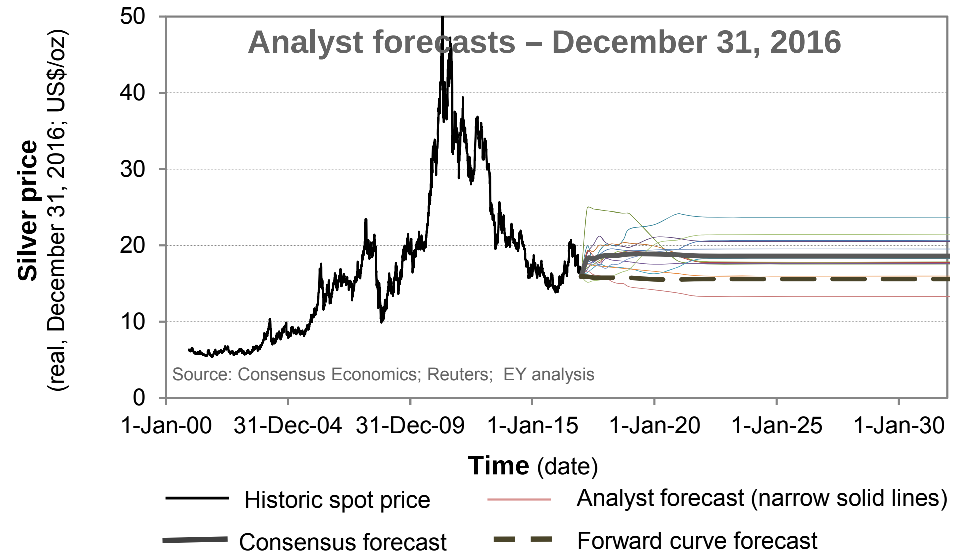
Silver price uncertainty model —
Analyst / consensus / forward long-term price forecasts

- Silver has mainly industrial uses with some investment interest. Mainly produced as a by-product.
- A range of analyst long-term price forecasts at both dates suggesting divergent business outlooks.

Forecast date	Long-term forecast price ($/oz; 30/12/16)			
	Analyst		Calculated / market	
	Low	High	Consensus	Forward
31-Dec-11	16.50	31.52	23.75	27.02
31-Dec-16	13.30	23.71	18.60	14.07

- Analysts were more in agreement in 2016 than in 2011 (less uncertainty).

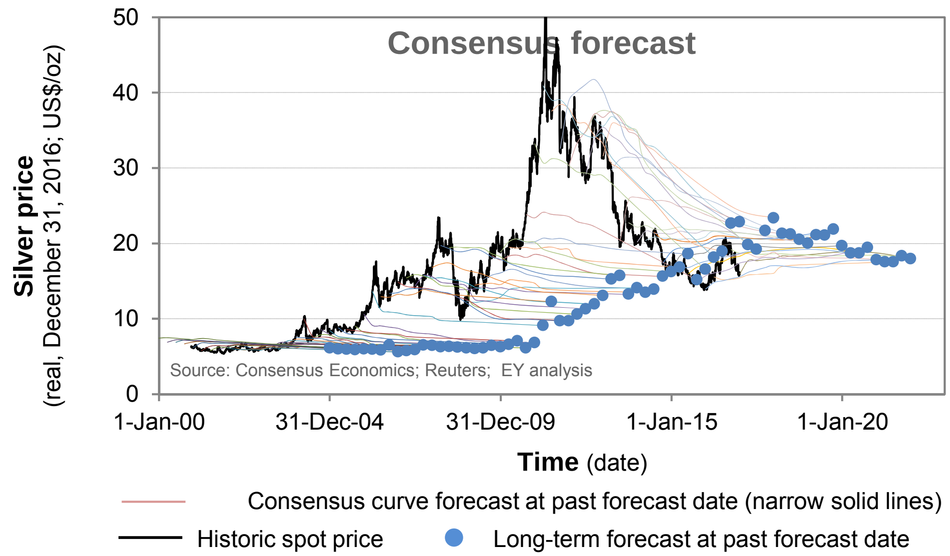


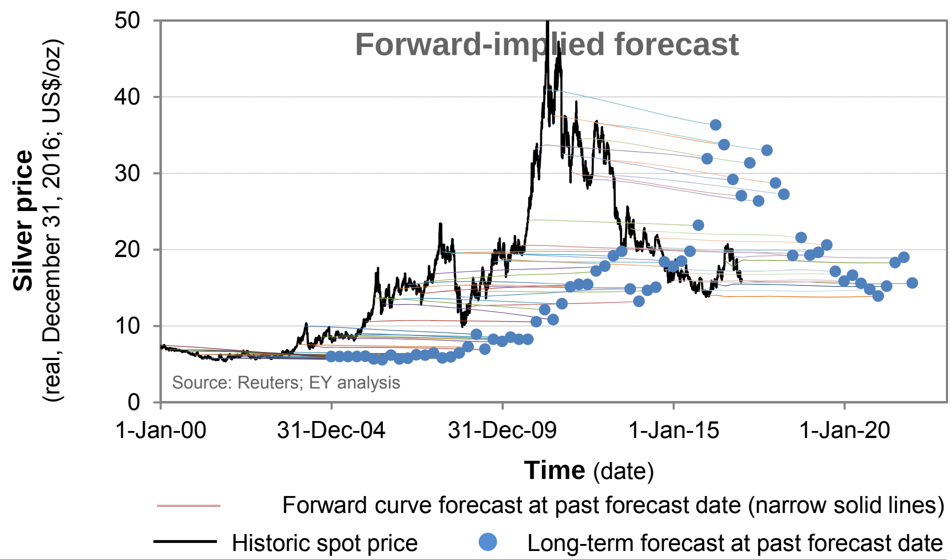


Sources: Reuters and Consensus Economics

Silver price uncertainty model —
Price behavior and forecast updating

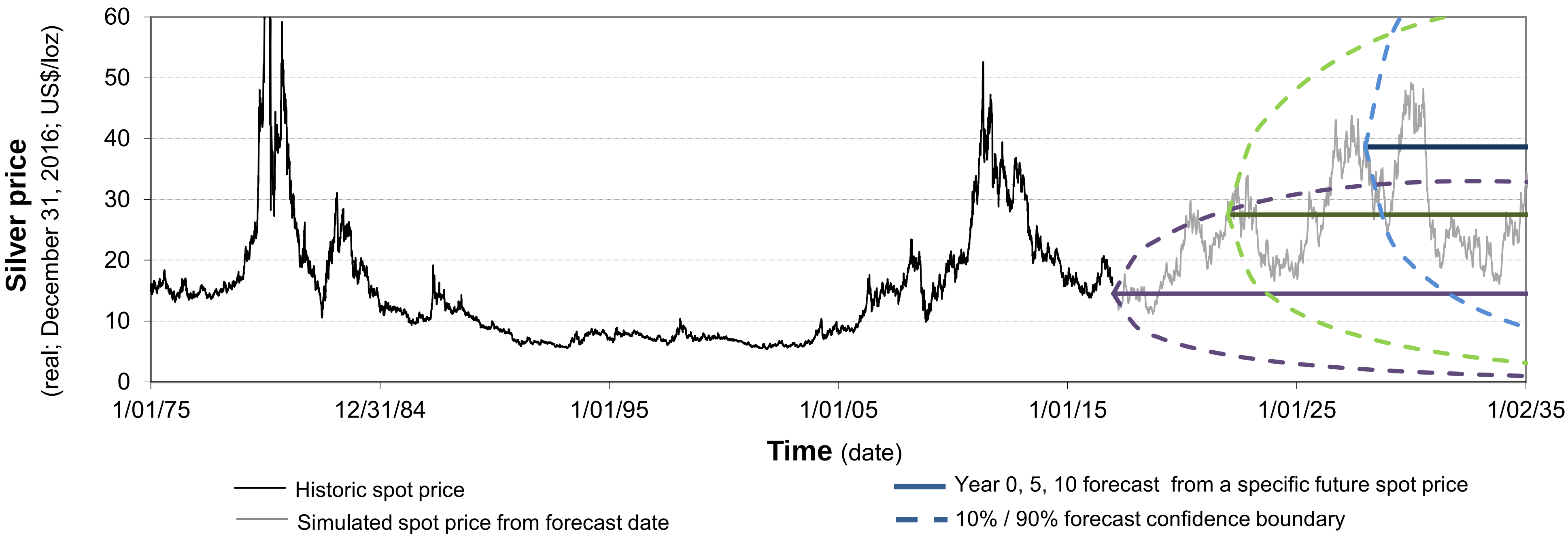
- Consensus forecasts again display anchoring – forecast updates are less reactive to spot market movements than forward-implied forecast.
- Forward-implied forecasts reveal general market pessimism over future silver prices compared with spot.
- Forward markets may be revealing either non-reverting prices or slight mean reversion to a price around $20/oz.





Silver price uncertainty model —
Simulated prices with one factor NREV uncertainty model

- Silver prices are modelled as a non-reverting process around an updating long-term forecast. This is reflective of by-product production as some production is unresponsive to price signals.
  - Volatility is estimated to be 32% using price data since 1967.
  - The stochastic model here assumes a flat forecast in real dollars at each date.
  - Past econometric analysis could support weak reversion.



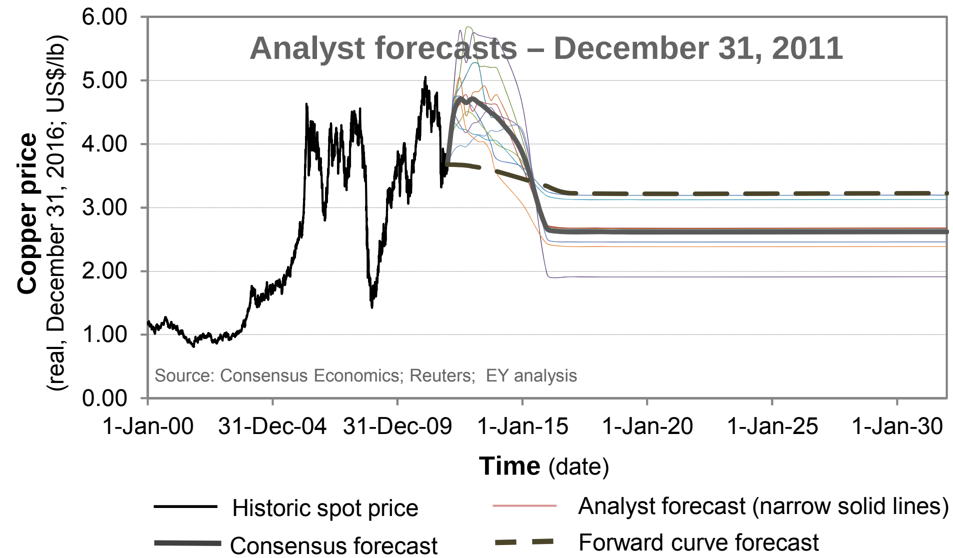
EY

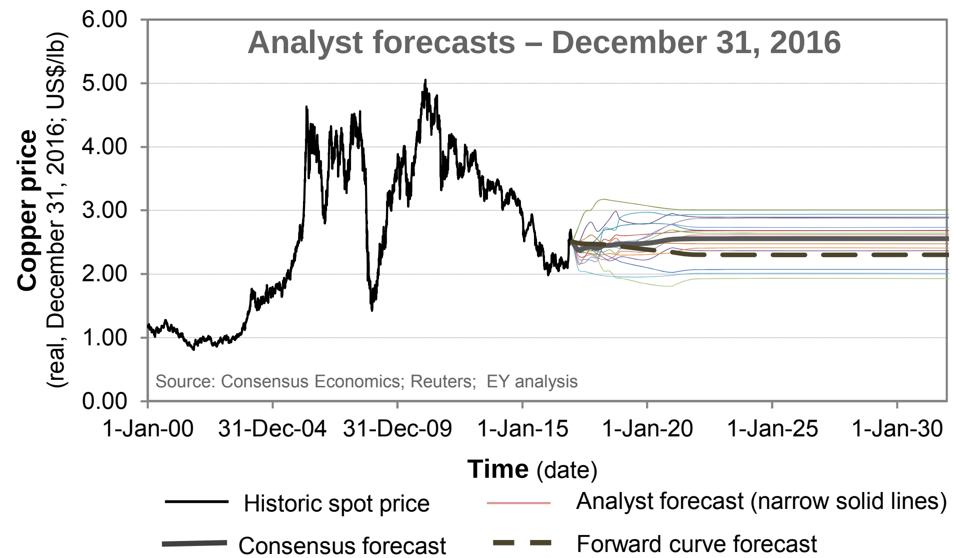
Copper price uncertainty model —
Analyst / consensus / forward long-term price forecasts

- Copper spot price trend influenced by supply and demand adjustments over time. These adjustments create a long-term price within a narrow band.

Forecast date	Long-term forecast price ($/lb)			
	Analyst		Calculated / market	
	Low	High	Consensus	Forward
31-Dec-11	1.91	3.20	2.62	3.23
31-Dec-16	1.93	3.01	2.56	2.30

- Contrary to forward markets, analysts forecast a constant long-term price no matter what the current state of the market.

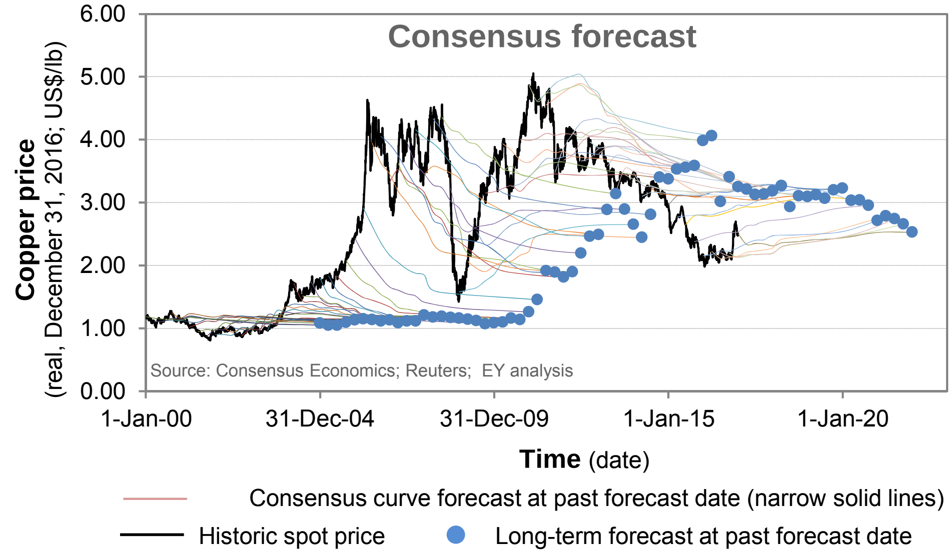


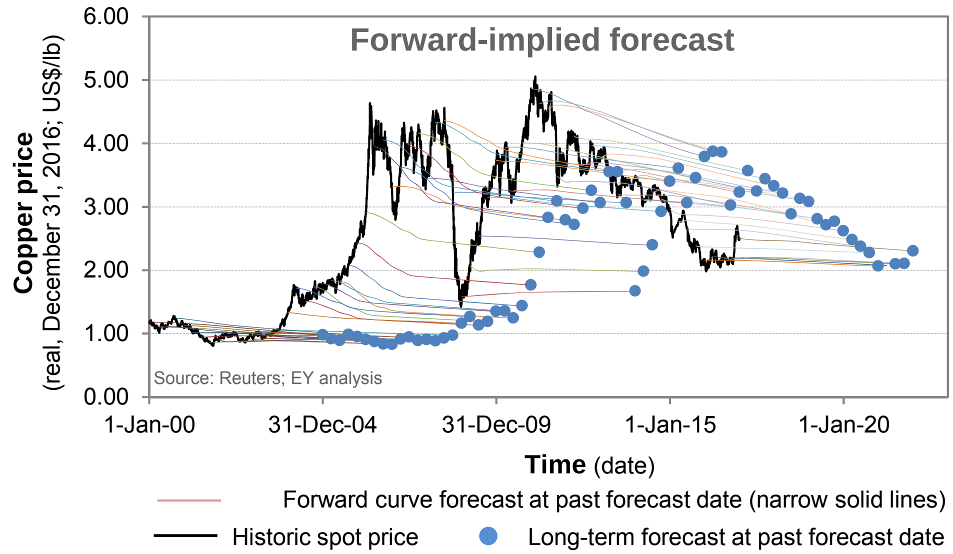


Sources: Reuters and Consensus Economics

Copper price uncertainty model —
Price behavior and forecast updating

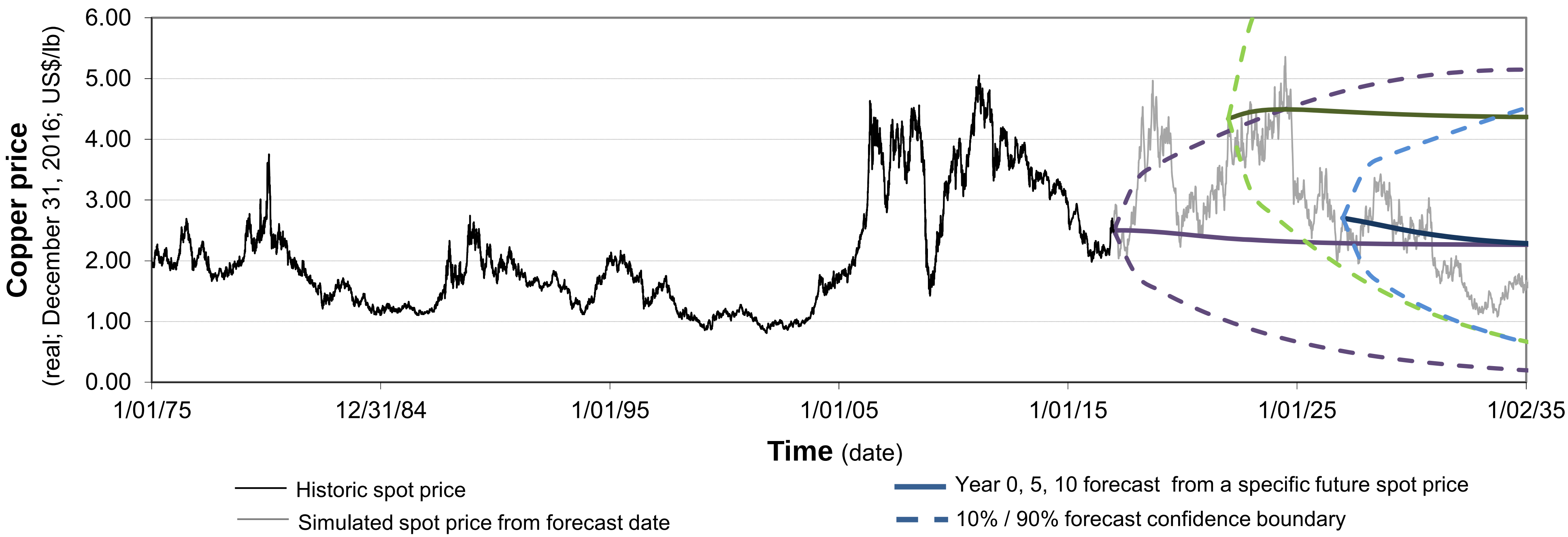
- Reversion exhibited by both consensus and forward-implied forecasts.
- Note the regime change (jump / high volatility period) in 2005, where the long-term forecast changed in both consensus and forward-implied forecasts.
- Analysts currently more optimistic than forward-implied forecasts.
- Difference may reflect copper market risk premium embedded in analyst forecasts.





Copper price uncertainty model —
Simulated price scenario with two factor+jump uncertainty model

- Copper prices modelled with a two factor + jump process to describe forecast uncertainty and forecast shocks.
  - Short-term price volatility is estimated to be 39% while long-term forecast volatility is estimated to be 6%.
  - Model jumps interpreted to reflect demand shocks such as increased demand from developing countries (2005) and GFC (2008).

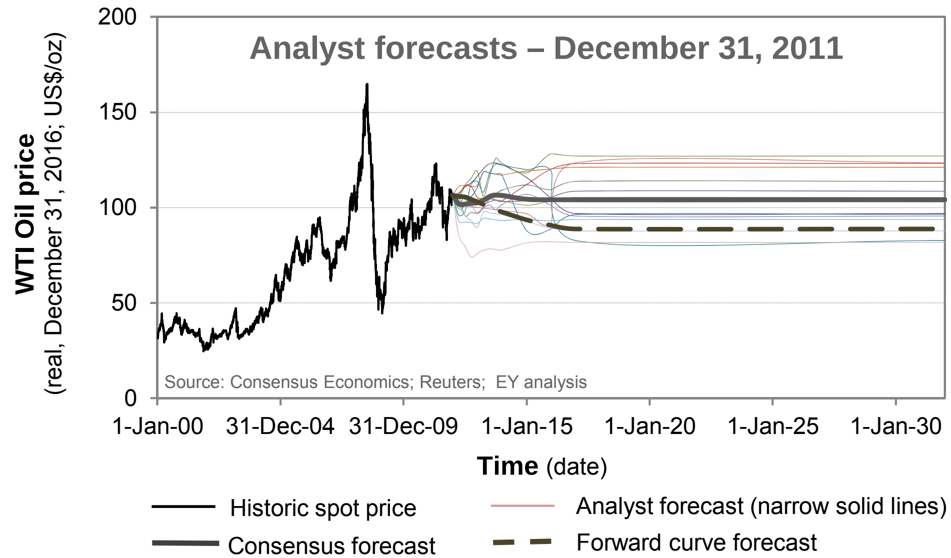


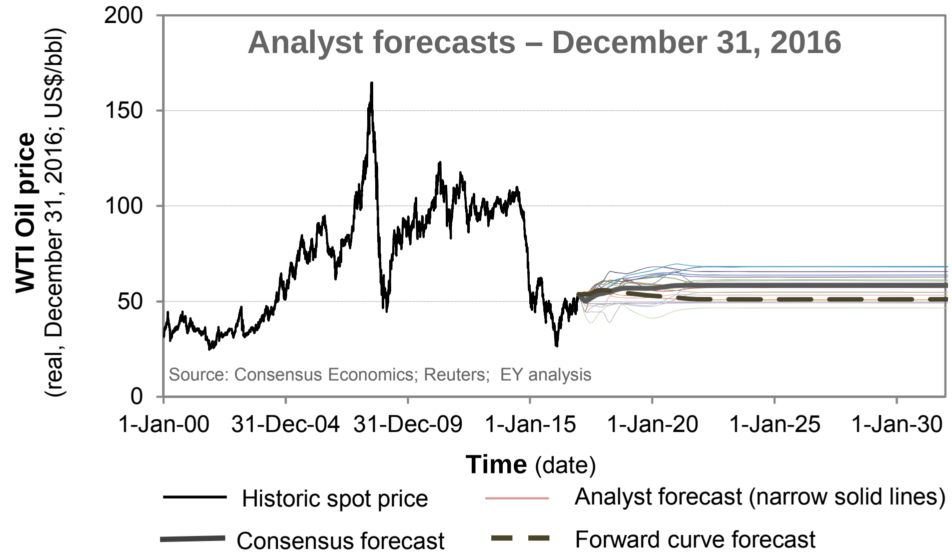
WTI oil price uncertainty model —
Analyst / consensus / forward long-term price forecasts

- Oil / diesel is a cost item for mining operations.
- Analysts view oil markets as having as much uncertainty now as in 2011.

Forecast date	Long-term forecast price ($/lb; 31/12/16)			
	Analyst		Calculated / market	
	Low	High	Consensus	Forward
31-Dec-11	81.74	127.05	104.08	88.81
31-Dec-16	46.52	68.41	58.43	51.11

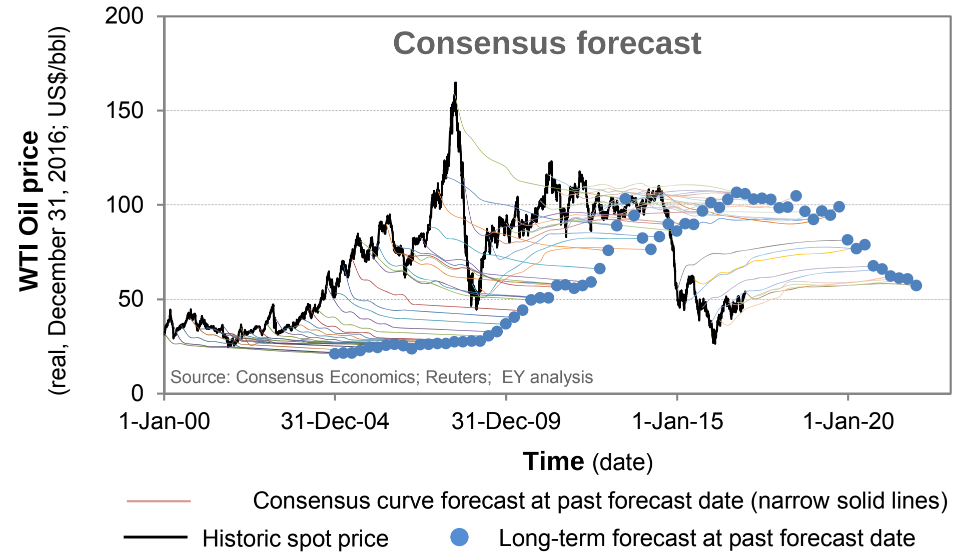
- While forecasts of metal prices have fallen since 2011, so have energy costs.
- Costs and revenues tend to move in tandem.

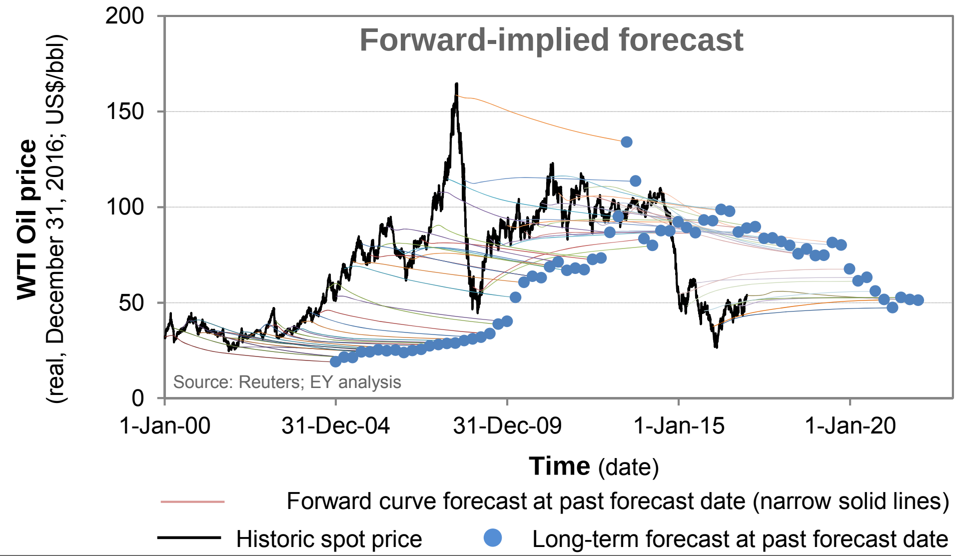




WTI oil price uncertainty model —
Price behavior and forecast updating

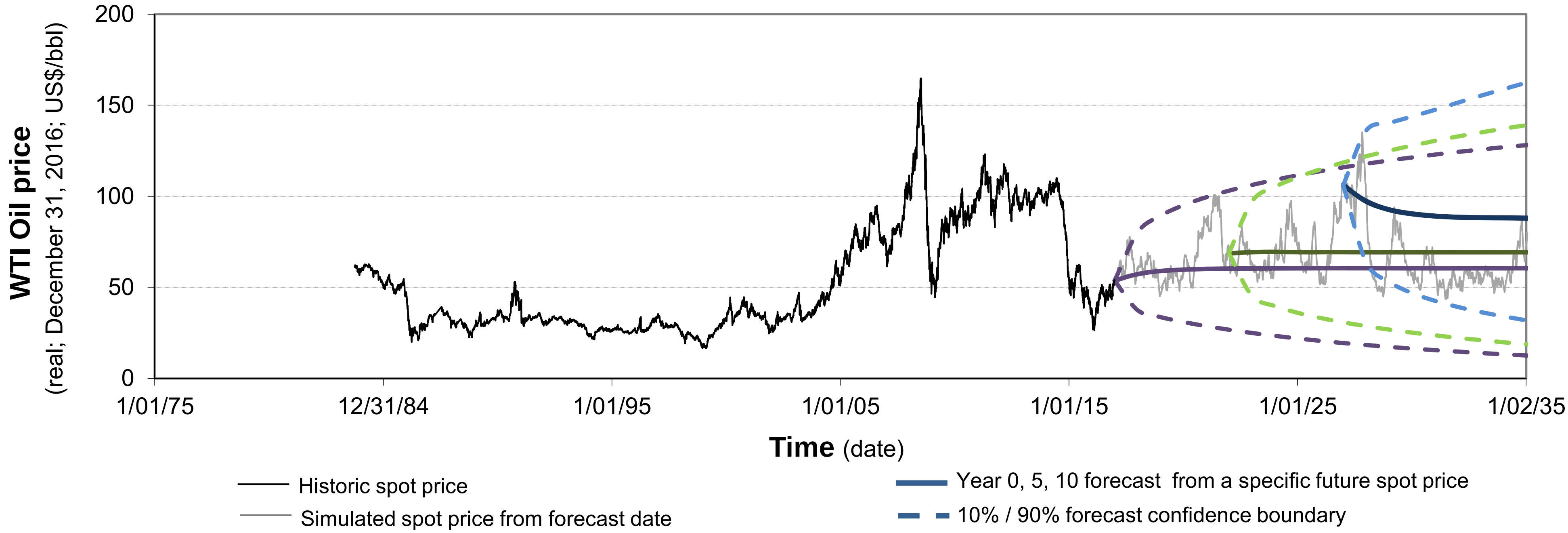
- Long-term forecasts affected by oil price rise in 2008. Even after the 2008 financial crisis, long-term forecasts reverted to a higher oil price.
- Reversion exhibited by both consensus and forward-implied forecasts after 2008.
- Consensus long-term forecasts and forward-implied forecasts are in broad agreement.





WTI oil price uncertainty model —
Simulated price scenario with two factor+jump uncertainty model

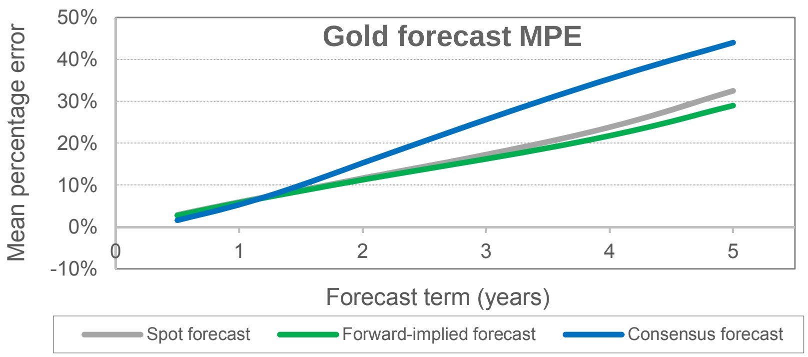
- WTI oil prices modelled with a two factor + jump process to describe forecast uncertainty and forecast shocks.
  - Short-term price volatility is estimated to be 25% while long-term forecast volatility is estimated to be 20%.
  - Model jumps interpreted to reflect supply and demand shocks such as shale oil technology (2007), Saudi production ramp up (2014) and OPEC supply cuts (2017).

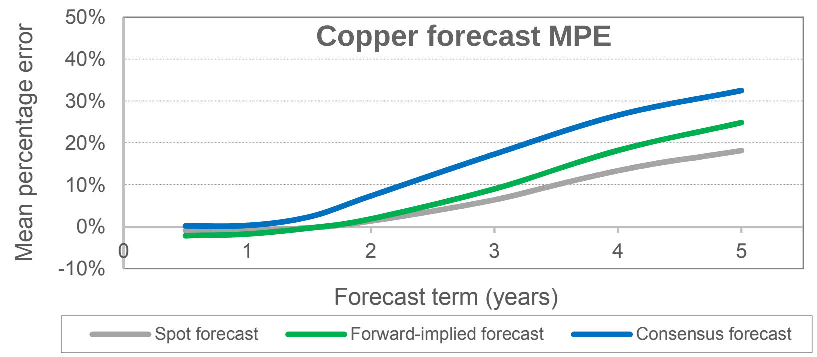


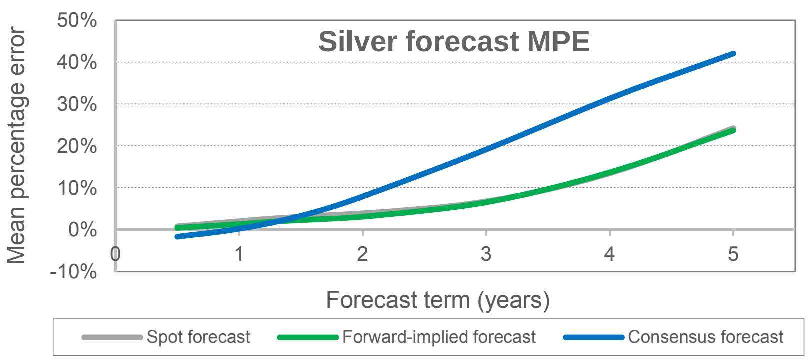
Comparing forecasting methods —

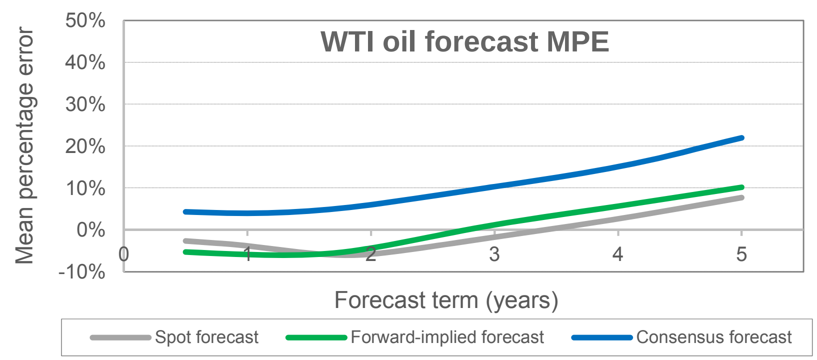
Which did better - consensus or forward-implied forecasts?

- The mining industry is often skeptical of using forward curves to infer price forecasts. Mean Percentile Error (MPE) of quarterly “naïve” spot price, forward-implied and consensus forecasts from January 1, 2000 suggests:
  - Consensus tends to have largest long-term forecast MPE for each commodity.
  - Gold, silver, WTI oil have lowest MPE with spot and forward-implied forecasts.









Modelling commodity price uncertainty —
Concluding thoughts

- One-factor and two-factor models can be used to reasonably describe future commodity price movements and forecast updates when appropriately parameterized.
  - Analyst forecasts and forward-implied forecasts suggest that constant real price assumptions may be problematic for base metals and energy.
  - Adding a jump component appears to be necessary for base metals and energy commodities.
- Simulation is the primary mathematical approach for translating these commodity price models into a large number of price scenarios.
  - Simulation scenarios can be combined with optimization techniques to investigate optimal design for operational flexibility and allow appropriate mine project valuation that takes into account operational flexibility (“blue sky potential”).

Appendix 2:
Presenter professional biography

Michael Samis, Ph.D., P.Eng.
Associate partner
Valuation & Business Modelling
Tel: +1 416 943 4487
Mobile: +1 416 527 3421

Email: michael.samis@ca.ey.com

Dr. Michael Samis, P.Eng. is a leading Integrated Valuation and Risk Modelling practitioner in the natural resource industries with more than 25 years of mining experience. He has extensive professional experience valuing base and precious metals, diamond, and petroleum projects with complex forms of flexibility and risk. His assignments have ranged from exploration stage to late-stage capital investments and have also included the analysis of project financing and contingent taxes. Mike has presented more than 30 professional courses on advanced valuation at universities, natural resource companies, and professional organizations world-wide and has published or presented numerous valuation papers about flexible pushback development, multi-stage exploration programs, windfall taxes, and the economic impact of project finance and hedging. Dr Samis is a registered Professional Engineer in Ontario, Canada, and a qualified person for project valuation under NI43-101 guidelines. In 2013, the Canadian Institute of Mining and Metallurgy awarded Mike with the Robert Elver Award for his contributions to the Canadian mining industry in the field of mineral economics. He holds a Ph.D. from the University of British Columbia that combines the fields of mining engineering and finance.

Dr Samis is currently an Associate Partner (Valuation and Business Modelling) in the Toronto office of Ernst and Young's Transaction Advisory Service where he and his team also value complex financial securities such as employee stock options, convertible debt with embedded derivatives, contingent contracts, and interest rate, commodity, and foreign exchange derivatives.

Professional background and qualifications:

University of British Columbia, Ph.D. in Mining Engineering and Finance
University of the Witwatersrand, MSc. In Mineral Economics
University of British Columbia, BSc. in Mining Engineering
Professional engineer registered in Ontario, Canada
Qualified person for project evaluation under NI43-101 guidelines
Member of the 2012 Review Committee for CIM Val Guidelines
Presented with the 2013 Robert Elver Award by the Canadian Institute of Mining and Metallurgy