



Nodule valuation methodology

International Seabed Authority webinar

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28 October 2020



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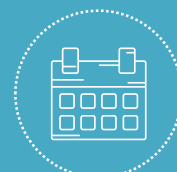
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CRU specialises in mining, metal, and fertilizer commodities delivering business intelligence through analysis, consulting, and events

Date	Commodity
1969	Copper
1973	Lead & Zinc
1980	Steel
1981	Nickel , Chrome, Molybdenum
1982	Iron Ore
1982	Ferro-Alloys
1985	Cobalt
1986	Stainless Steel
1987	Metallurgical Coal
1988	Steel Sheets
1989	Ferro-Chrome
1990	Steel Long Products
1991	Steel Plate
1991	Wire & Cable
1992	Manganese
1997	Coke
2012	Alumina Price Index
2014	Thermal Coal
2016	Lithium

Background and objectives

- Section 8 (1) (b) of the Annex to the 1994 Agreement relating to the implementation of Part XI of the United Nations Convention on the Law of the Sea states that “the rates of payments under the system shall be within the range of those prevailing in respect of land-based mining of ***the same or similar minerals*** in order to avoid giving deep seabed miners an artificial competitive advantage or imposing on them a competitive disadvantage”;
- This is challenging to interpret given the lack of clear comparisons in terms of both the technical and extraction processes, and the associated economic values (given the lack of directly comparable products). Designing a fair and broadly comparable fiscal regime therefore requires an in-depth understanding of:
 - the relevant mineral value chains (and relevant land based alternatives)
 - the likely economic value of intermediate products considering relevant market comparators and specific seabed related extraction and processing costs

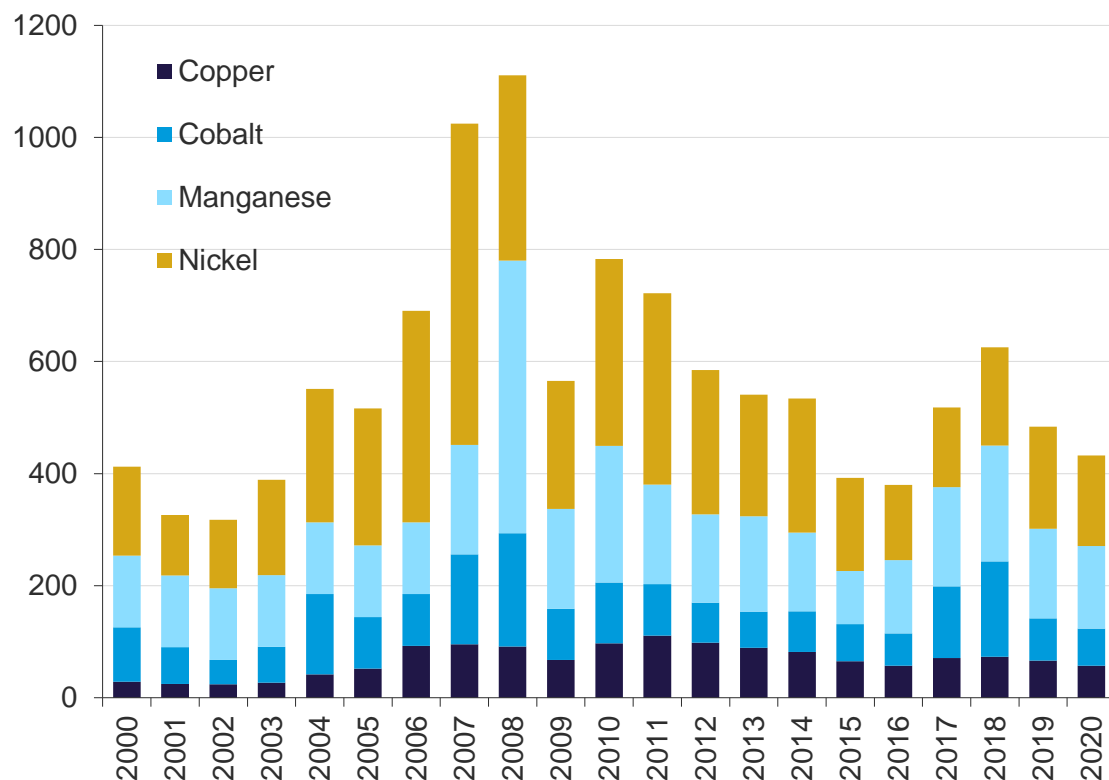


Objective:
To advise on the **most appropriate valuation methodology for undersea polymetallic nodules** for the imposition of royalties

Polymetallic nodules are unique, with no clear land-based analogue

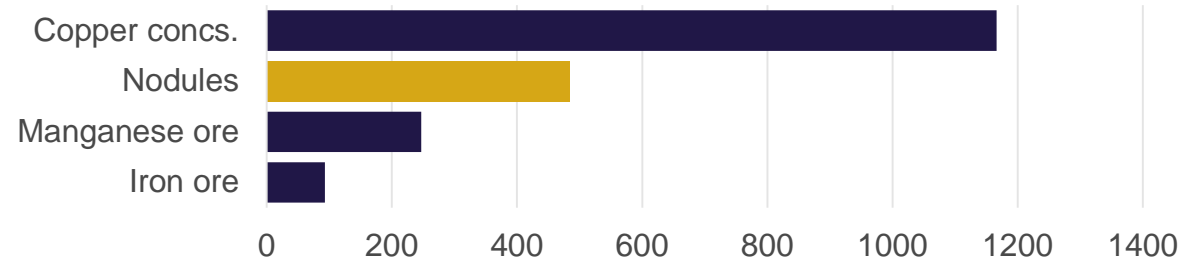
The gross value of the metal content of the nodule is high, and displays significant historical volatility

Gross value of nodule metal content based on historical prices, real 2019 \$/tonne nodule



- At 2019 average prices, the gross value of the nodule is estimated to be \$484/tonne, which would be equivalent to the gross metal content value of a theoretical 8% copper ore. As most run of mine copper grades are around or even below 1% Cu, it is clear that the in-situ value of the nodules is comparatively very high.
- The nodules clearly have a high gross metal content value, and this should be kept in mind while developing the royalty system.

Value of one tonne (gross weight, 2019 prices)

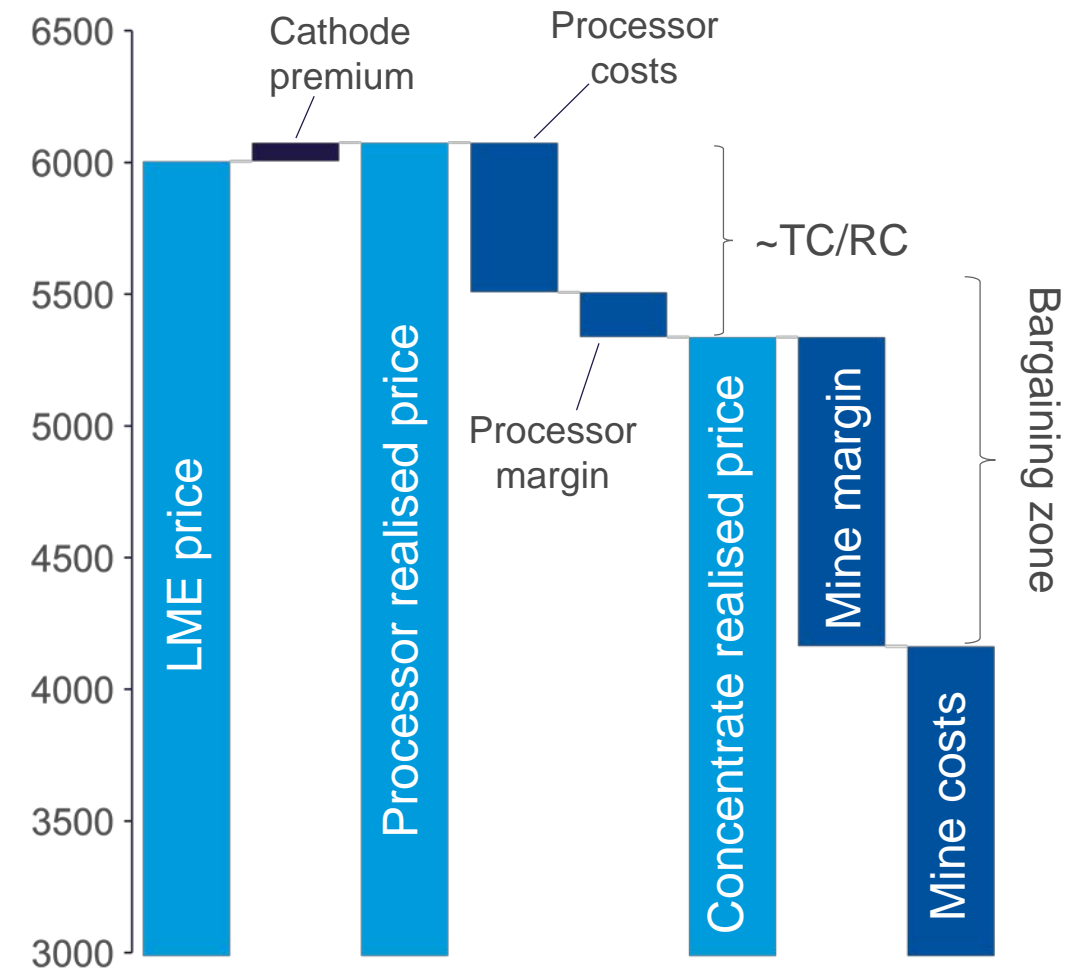


The gross metal content value of the nodules does not represent their fair value

Unfinished materials are not paid for at the full metal content value

- In land-based mining, a purchaser of raw materials will not pay for the full value of the metal contained within raw materials, instead deductions against the reference price for the metallic content of this material (e.g. the LME price for copper concentrate) will be made either explicitly or implicitly
- Deductions will account for, at a minimum, **metallurgical recoveries, processing costs, and realisation costs.**
- Beyond these minimum deductions, a price will be driven by factors such as **market dynamics, the ratio of operating and capital costs between buyer and seller, the risk taken by each party, etc.**
- Lower value, bulk materials, such as iron ore, manganese ore and nickel laterite ore are typically sold on a fixed price basis per tonne of ore with no explicit reference to a reference price for the finished product itself.

Copper prices and typical cash margins by stage



Determining a fair value for polymetallic nodules is highly challenging

No current transactions involving this material

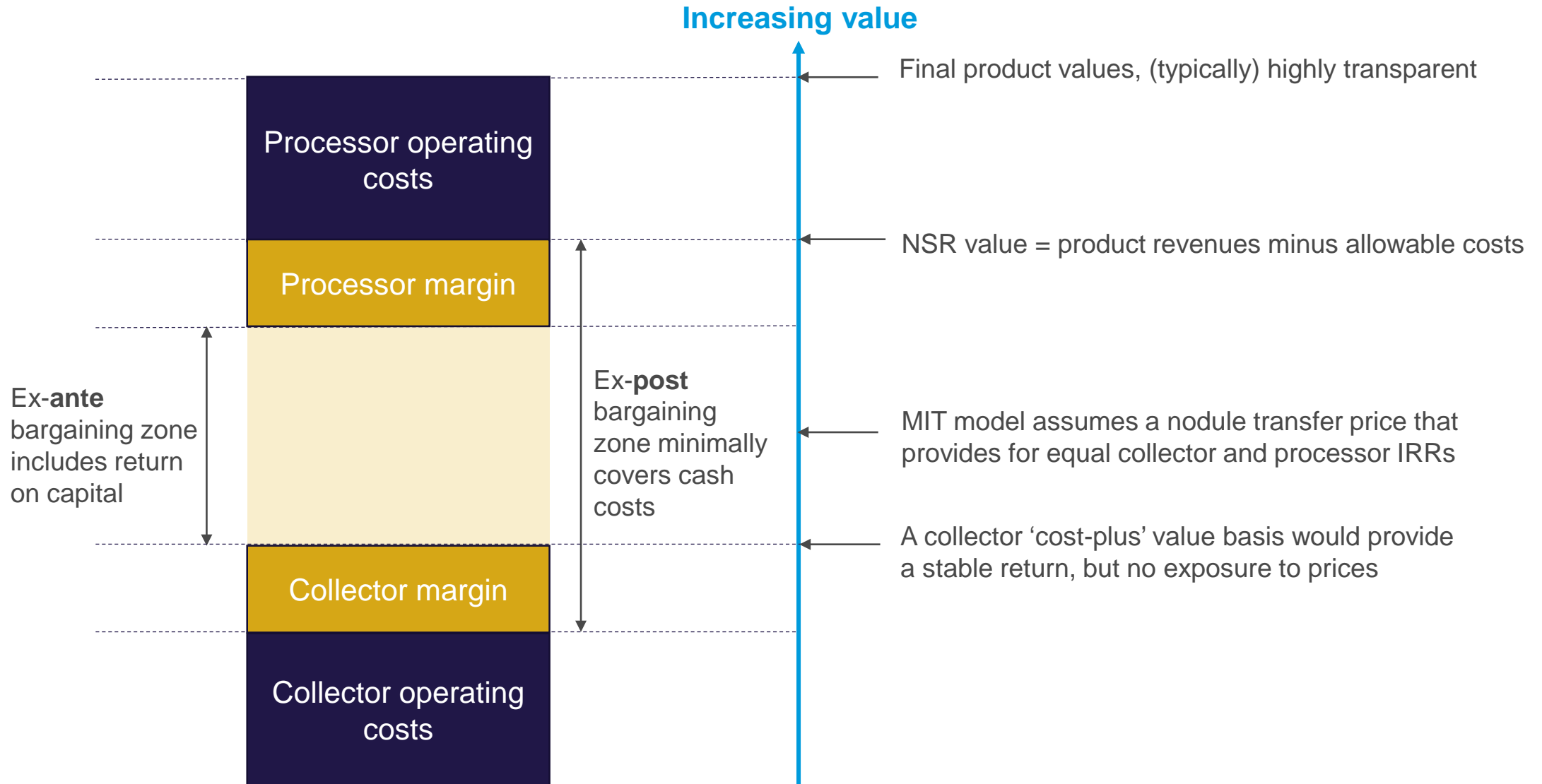
No existing operations from which to estimate costs

No precedents for the allocation of price risk between collector & processor

No direct analogues in land-based mining and processing

- Even after polymetallic nodule collection and processing facilities begin operating, reported transaction prices may not provide a fair representation of the nodule value:
- For a transaction to be considered a fair representation of the value of a particular material, **a willing buyer and a willing seller, acting at arm's length, in a competitive market** is required.
- **These criteria are unlikely to be met in the case of the nodules**, even if the collector and processor are acting at arm's length and not co-owned. Given the unique nature of the nodules, and the likely custom design of the processing plant to refine the material, neither party has a reasonable alternative to selling to each other. Bargaining zones between parties can sometimes be established by looking at Next Best Alternatives (BATNAs), but in this case, it is likely that both parties next best alternative would not be economically feasible.
 - A few smelters with polymetallic processing capabilities worldwide that might be able to process the nodules, but have their own sources of raw materials and little incentive to take the nodules
 - The processor would not have a ready source of raw materials other than the nodules and would be in a weak bargaining position to secure what concentrates or intermediates might be available.

Without transparent prices, we can determine fair value with bargaining zone analysis

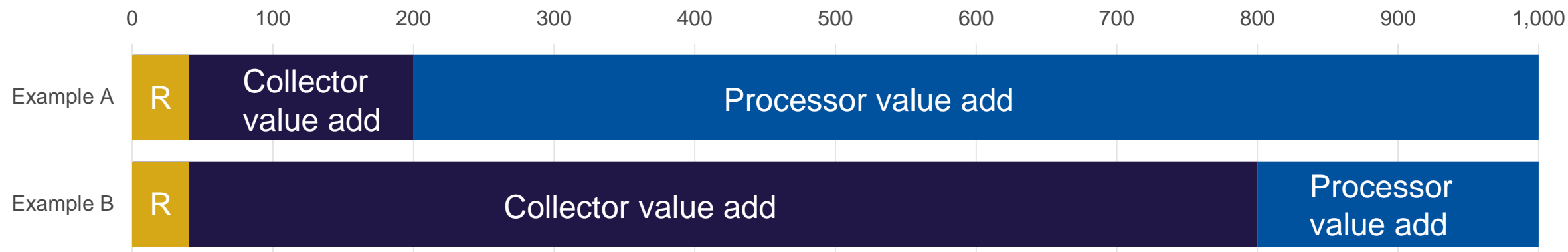


Can we just use the gross value of the metal content of the nodules?

Yes.... **BUT** the problem with this is that the **burden of such a royalty depends on the value added by the mine**

Taking the example of a simple 3% ad valorem royalty:

- Assume two metals, each selling at \$1,000/tonne, In metal A, the mine adds just 20% of the value, while in metal B the mine adds 80% of the value.



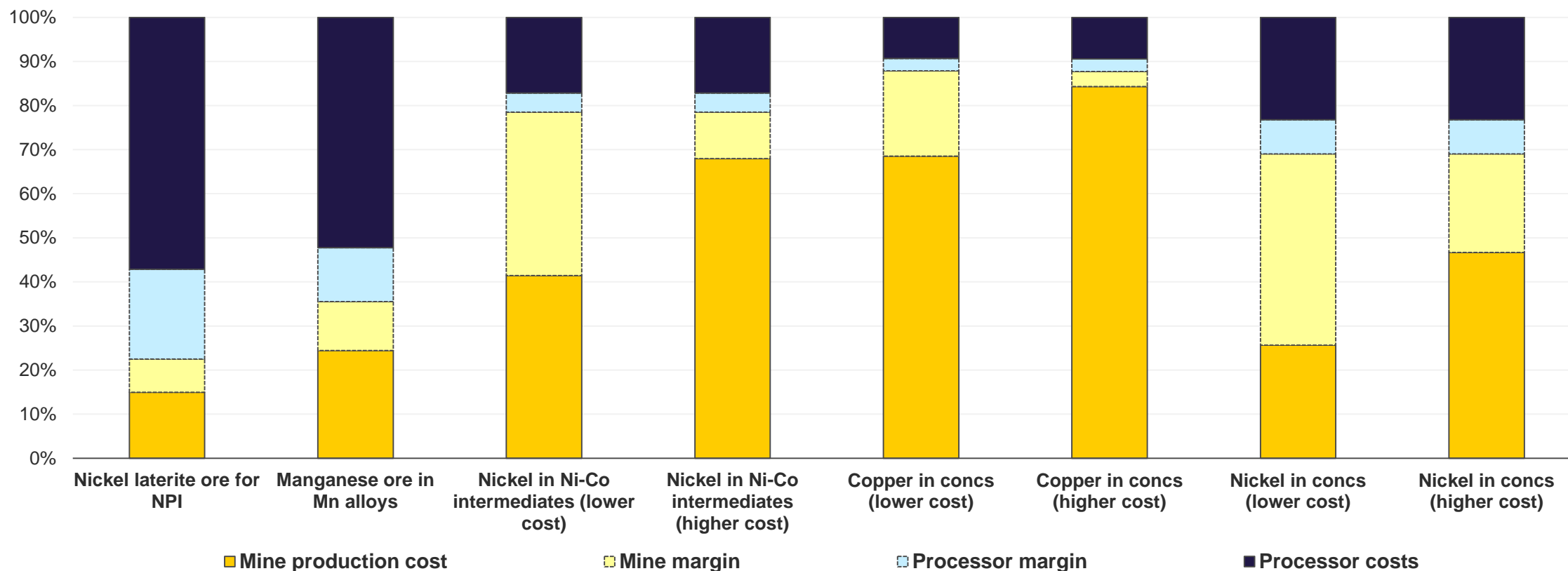
- For metal A the burden of the royalty on the mine is $30/200 = 15\%$, whereas for metal B, the burden is $30/800 = 3.75\%$.

Thus, even if the owner of mineral rights opts for the simplest form of ad valorem royalty, **understanding the value added by the nodule collector is necessary in setting the royalty rate.**

Unfinished material prices align with processing costs to that point (i.e. value add)

e.g. nickel laterite ore mining costs are roughly 15-25% of the LME nickel price; ore prices are usually a similar % of LME.

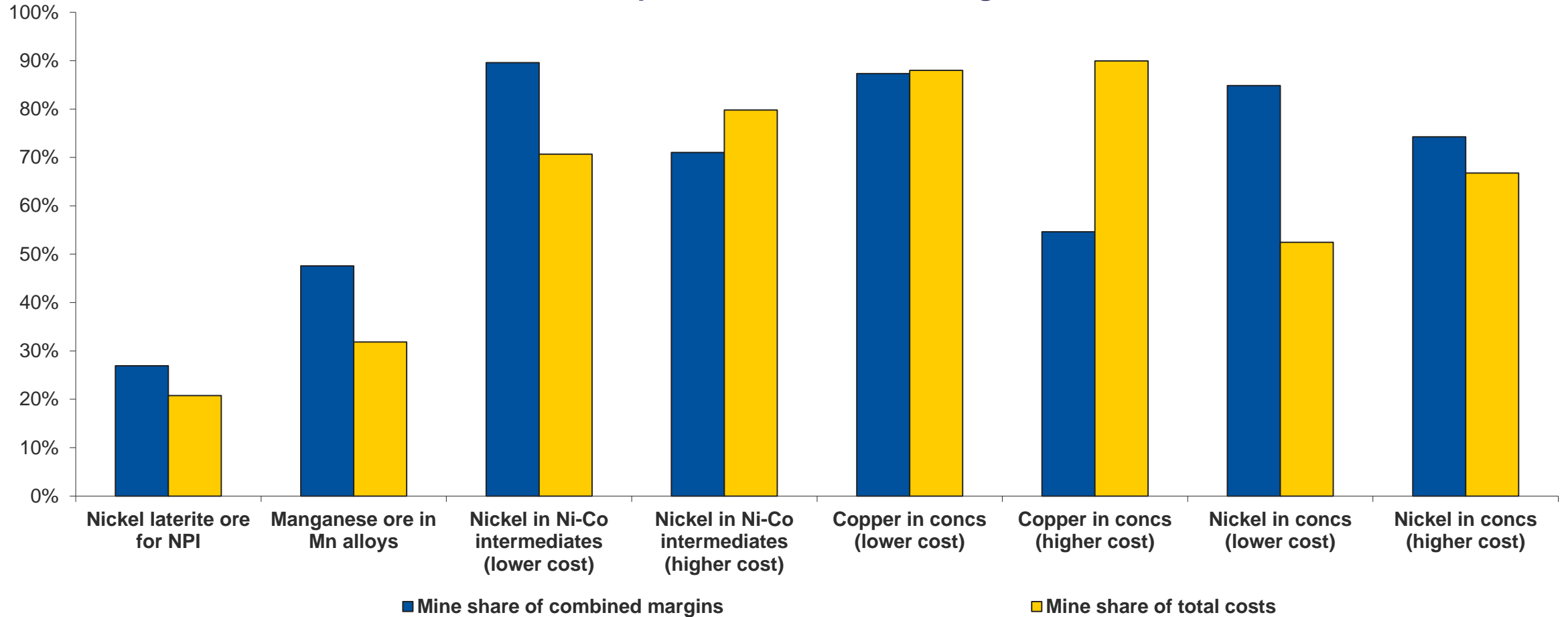
Typical attribution of price across mine and processor (% of finished product price)



Therefore costs make a good proxy for value addition where unfinished material prices are unknown

The party that adds the most value tends to take more final product price risk

Mine shares of combined mine and processor costs and margins for different unfinished materials



A 'fair value' estimate is not necessarily the best valuation option for a royalty

Attempting to calculate the 'fairest' point in the bargaining zone between collector and processor in the case of the nodules can be undertaken, indeed an estimation of the midpoint of the bargaining zone is effectively what the MIT model calculates

However, **this methodology to calculate nodule value is not readily usable for the determination of royalties in practice**, for the following reasons:

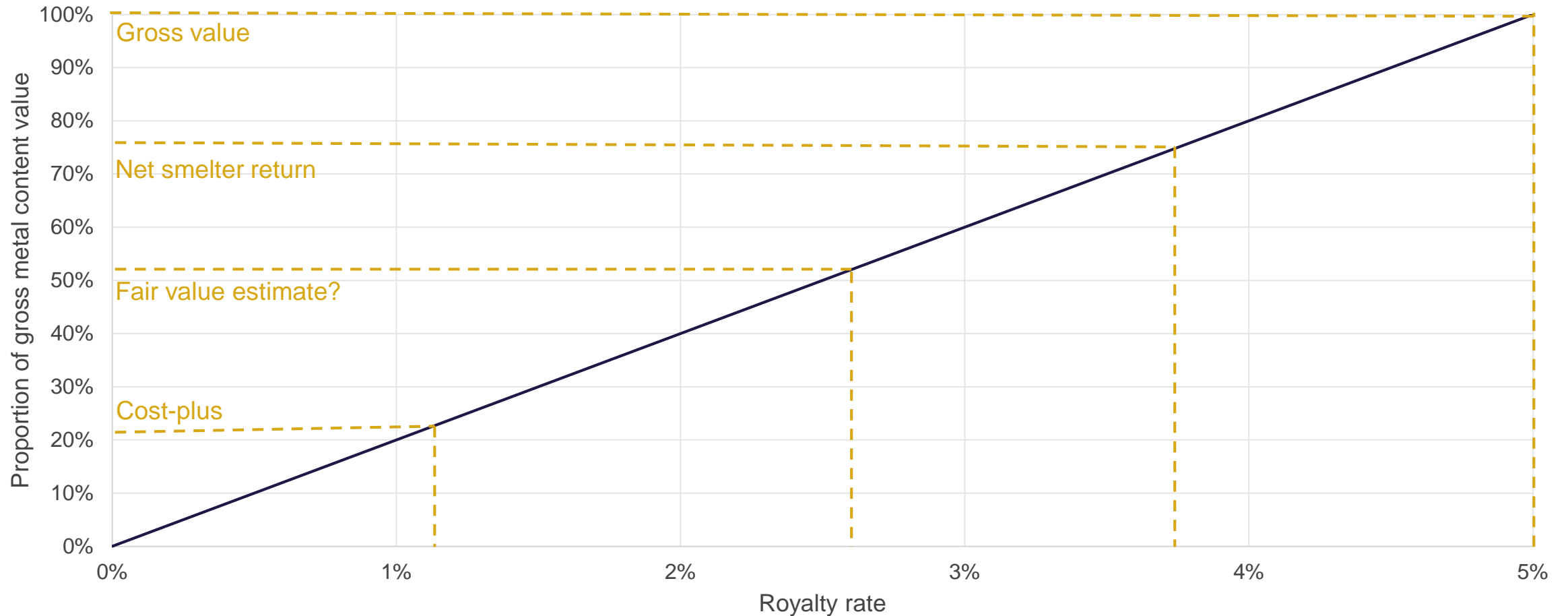
- It is reliant on costs which are not known with sufficient accuracy ex-ante;
- Capture of repayment on capital costs is factored into the calculations ex-ante, but this assumption may not be reasonable ex-post;
- It requires both collector and processor operating and capital costs as inputs, increasing the number of variables and therefore uncertainty and margin of error;
- In practice, relative collector to processor costs will vary over time, therefore the fair value position in bargaining zone would require constant monitoring and recalculating if this metric is used to drive the royalty value basis: difficult to administer, complex, non-transparent and uncertain

Therefore, **CRU recommends that alternative valuation bases might be considered that are simpler, more transparent, and easier to monitor on an ongoing basis.**

Value basis and royalty rate are inter-dependent

Value basis selected nodules is only half of the equation – the royalty rate applied being the other

Illustrative royalty rate changes to keep burden consistent at different valuation points



Different valuation basis options have different advantages and disadvantages

- **Gross metal value:** very simple to calculate and monitor, but unfairly overburdens collector (if no allowance made for processing costs)
 - **Net Smelter Return:** incorporates price exposure; pays out under all but lowest price scenarios, and a sliding royalty scale could capture excess profits at higher prices. Also, this requires only one set of costs as inputs (the processor's), reducing the margin for error.
 - **Some point within bargaining zone:** perhaps this would provide arguably the truest sense of 'fair value' of nodule, but it is reliant on a larger number of cost inputs from both the collector and producer, presents a greater administrative challenge and cost, with less transparency, and as a valuation determination it is possible that ex-ante assumptions may not match ex-post reality.
 - **Collector cost-plus:** presumably high revenue stability (although far greater uncertainty around deepsea collection costs compared to land-based mining), potentially greater acceptability to collection operators; no price exposure.
 - **Profit-based:** this has least impact on project economics, more attractive to investors; payments may be delayed until pre-production costs paid off; increases chance of no payment in low price environments; more susceptible to manipulation
 - **Production based:** similar to a cost-plus basis, this is a specific royalty (as opposed to ad valorem) which provides even greater confidence in future royalty earnings, but no exposure to prices.
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High degree of uncertainty around manganese presents a particular problem

- The form in which manganese content of the nodule will be recovered by the processor is uncertain, so:
 - The **reference price for royalty calculation** is much less clear than for nickel, cobalt or copper (the LME) – and the differential is substantial: **EMM is 3 to 10 times the price of manganese ore per unit Mn**,
 - and the likely **realised price relative to this reference price** is also much less clear and probably not proven until sales begin

- If sold as MRS: similar chemical characteristics to conventional Mn ore (and same end market), so ore price would be relevant reference, but the actual realisable price very much unproven – cannot assume that it will be the same level as benchmark ores
- **CRU notes that it would be important to closely observe transactions of this material in order to determine whether royalty rates are reasonable based on actual realised price**

- If sold as downstream higher value-add product, e.g. EMM or Mn alloys: then price for this first saleable product becomes the relevant reference price for the royalty.
- **The royalty system should return a similar payment on nodule collection regardless of the extent of value add that occurs outside of the ISA's jurisdiction:**
 - the royalty rate on manganese converted into MRS ought to be higher than if it is instead converted into a higher value add product

Options to address this uncertainty:

- Specific royalty (fee per tonne of Mn in nodules removed) – no price risk
- More realistically: system makes allowance for adjustment to royalty regime as uncertainty is reduced

Summary

- **Polymetallic nodules are unique**, with no clear land-based analogue; the gross value of the metal content of the nodule is high, and displays significant historical volatility
- The **gross metal content value of the nodules does not represent their fair value**; it does not recognise the value addition at each of the collector and processor
- **Determining a fair value for polymetallic nodules is highly challenging**
- In the absence of transparent pricing, a **fair value can be determined by analysis of the producer-consumer bargaining zone**
- Value-add vs price relationship for comparable land-based materials shows that **prices for unfinished materials are closely related to the proportion of overall costs required** to process the materials into that state
- Costs for deep sea nodule collection and processing currently have a large margin of error – adding risk to a key input
- A best estimate of a nodule's fair value **is not necessarily the best option as a value basis for the nodules for the purposes of extracting a royalty in practice**
- **The value basis and royalty rate are inter-dependent, and cannot be fully assessed independent of each other**; what is important is that the burden of the royalty on the collector is reasonable
- **Different valuation basis options have different advantages and disadvantages**
- The manganese content of the nodule presents a particular difficulty
- The **royalty regime should allow for adjustments to be made at or soon after operation begins**, as many uncertainties with respect to valuation will be diminished at that point



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