Valuation Simulation for a Net Smelter Return Royalty on a Mining Project

Bell, Peter

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Abstract

This paper provides a rough calculation of the economic value of a hypothetical mining operation for a profitable of mineral deposit. I present simplifying assumptions for the deposit geometry and mine production constraints to calculate the value of a net smelter recovery royalty on the mine, which is due a small fraction of gross income from the mine. I calculate the value of the royalty with constant prices and conduct a simulation exercise where the metal price changes quarterly based on historical data for gold futures contracts.

Keywords: Engineering Economics, Mining, Royalties, Finance

JEL Codes: C00 General; G00 General; L72 Mining, Extraction, and Refining

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This paper considers economic aspects of a hypothetical mineral deposit and mine operation. I describe the geometry of the deposit and mining constraints for a stylized auriferous tourmaline breccia pipe, which is an important part of porphyry systems as in Bell (2018b) about my concepts for mining methods at an auriferous tourmaline breccia pipe. This paper demonstrates the valuation of a Net Smelter Return (NSR) royalty using a simulation method that I presented in Bell (2018a), which includes variation in metal price based on historical data. The paper proceeds by describing royalty, mine constraints, and valuation.

Auriferous tourmaline breccia pipes are interesting as they allow large amounts of ore to be found in relatively small spaces because they are so voluminous. See the Los Sulfatos mine, or the "Red Spring" target at the Hazelton project under Jaxon Mining, or the Soledad project with Chakana Copper for more. Chakana (2018) describes how a single pipe with diameter 600 meters taken to depths of 100 meters depth gives 14 million tonnes of ore. That is a large amount of ore, equivalent to a single vein with 1.5-meter width and 250-meter depth running for 12.5-kilometer strike. It would almost surely take less time to mine such a pipe than the equivalent of such a vein.

Introducing NSR Royalty

Franco-Nevada has a major influence on use of royalties for mining finance. On their website, Franco-Nevada (2018) describes the basics of an NSR royalty. They write, "multiplying the number of attributable royalty ounces times the assumed average future gold price can provide a rough approximation of the potential undiscounted pre-tax cash flow to Franco-Nevada from that asset before metallurgical recoveries." That is a great place to start with the valuation of an NSR. There is more to be done and I also consider amount of ore mined over time period, contained metal, metallurgical recovery, and metal prices.

I use an assumed average future gold price but also conduct other calculations where allow future gold price to change in way follow historical episodes. I consider a series of such episodes to get distribution for royalty value by using prices from different historical episodes. It is important to consider uncertainty in this way as the valuation of a royalties is always a speculative act.

Royalties on mineral exploration and development projects are highly speculative. There is great uncertainty around whether such a project will ever go into production or stay there. Valuation of royalties on mines that are currently in production have more certainty and can be valued using methods for fixed income securities but still have uncertainty over future payments.

Introducing Mineral Deposit

I consider a pipe with radius 30 meters and depth 1km, which has total volume approximately 3 million meters cubed or 10 million tonnes of ore. I assume underground mining is possible at 10,000 tonnes per day for 1,000 days of mine life at 250 days per year for 4 years mine life. I also assume there is one year pre-production time before the mine goes into production and the NSR starts to receive payment.

I assume the ore grade is 1/8 of ounce per ton gold equivalent. This gives a total of 1.25M ounces total production or approximately 300,000 ounces per year. A 2% NSR will receive 6,000 ounces gold equivalent per year at a constant rate in this example.

Valuing the NSR

As mentioned by Franco-Nevada (2018), I calculate the undiscounted pre-tax cash for a 2% royalty using gold price $1,300. Total mine revenue is approximately $1.6 billion and a 2% NSR pay $32M on an undiscounted pre-tax cash basis.

At a 10% discount rate, the value of the NSR is $22.5 million. This result may be unrealistically large for several reasons. For one, I assume 100% recovery and no significant eligible charges for NSR. For another, I assume the mine starts paying next year. That's quite an aggressive timeline and reflects the fact that this should be seen as a description of the value of the NSR when the mining is going into production. In production, the NSR holder receives 6,000 ounces at $1,300 for $7.8M cash flow annually.

Simulation Results

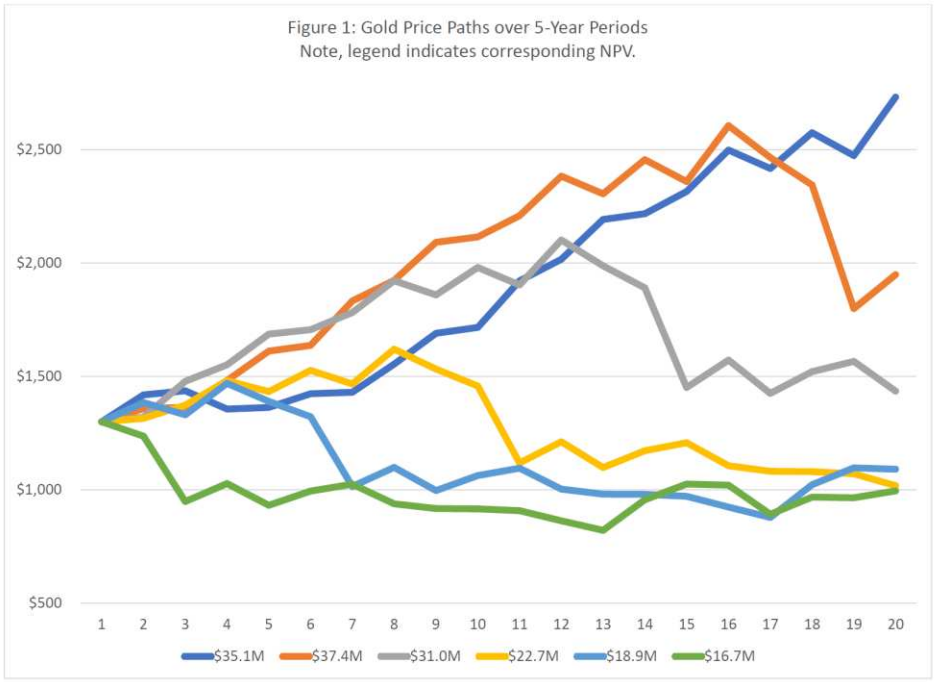
I allow the gold price to change in simulations for each price path, which describes the gold price quarterly over a 5-year period. I consider 6 such periods, each starting January 1st from 2008 to 2018. Each price path starts at $1,300 and use chained differences in gold prices on a quarterly basis to create price paths.

I use data from Quandl for the CME Gold futures continuous contract 2 months to maturity as with the following command in Excel:
=QSERIES({"CHRIS/CME_GC2/SETTLE"},{"2008-01-01","2018-01-01"},"quarterly")

Start Year	*NPV*
2008	$35.1M
2009	$37.4M
2010	$31.0M
2011	$22.7M
2012	$18.9M
2013	$16.7M

I report the NPV for the 2% royalty described above using the price path starting in each year, as above. Recall that the valuation with no uncertainty is $23.0M, which is right in the middle of the distribution as there are 3 simulated values above that value and 3 below it. Note also that the distribution has a favourable feature: positive skew. The lowest value is 30% smaller than the baseline value for the NSR, whereas the greatest value is 60% larger.

To understand how these different estimates of value for the NSR are calculated, see the price paths shown below. Figure 1 shows the gold prices used for each simulation. The initial price in Figure 1 is $1,300 for each run and then the prices are updated according to historical episodes.



The Figure 1 shows several intuitive features, such as the fact that the smallest estimate for value of the NSR corresponds to the price path that decreases the most quickly and stays the lowest for longest. It is interesting to compare the price paths associated with the 3 largest NSR values, as they have a more complicated relationship that surely reveals further interesting structure about the data.

Note, data file online at ***http://cdn.ceo.ca/1djj3s3-2018-07-01-NewtonWorkfile-ValuationSimulation.xlsx***

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