Optimal Exploitation of a Mineral Resource under Stochastic Market Prices

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Abstract

In this chapter we study the long-term operation of a mining project. We model the project as a collection of blocks (minimal extraction units) each with its own mineral composition and extraction costs. The decision maker’s problem is to maximize the economic value of the project by controlling the sequence and timing of extraction, as well as investing on costly capacity expansions. We use standard contingent claim analysis and risk-neutral valuation to solve the problem for a fixed sequence, taking as an input the stochastic process that regulates the dynamics of futures prices. Our solution method works in two steps. First, we consider a fixed production capacity and use dynamic programming to compute upper and lower bounds for the value function in terms of the spot price and mineralogical characteristics of the blocks. We use these bounds to obtain an approximation that is asymptotically optimal as the spot price grows large. In the second step, we extend this asymptotic approximation to handle capacity expansion decisions. Numerical computations are used to evaluate the performance of our proposed policy. Finally, we apply our methodology using data from a real project at Codelco (the world’s largest copper producer).