

## HOW SPACE MINING MISSIONS WILL DISRUPT MINERAL MARKETS AND CONTRACTS.

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**Abstract:** As the prospect for mining nearby asteroids for minerals that are valuable on Earth becomes more feasible, the business case is becoming more important. One large concern with the business case for space mining is high uncertainty about the price a space mining company can expect to receive for its asset. Current discussions around the potential revenues that come from mining a nearby asteroid generally take the current market price of the mineral in question as the price the mining company would receive. Once it is clear that the space mining company is bringing a large amount of a mineral to Earth, however, the price will fall. This research models the changes in market equilibrium and contracting structures that a space mining company and a mineral buyer should expect to encounter. Contracts in this context must provide the space mining company with enough revenue to make the mission profitable and ensure that the buyer stays in business after the mission has succeeded.

One important barrier to space resource production is the tremendous uncertainty over how the market will react to the new source of supply, and related, how to finance space production and transport activities given this uncertainty. Such risks have been recognized by analysts in recent news reports[1]. Buyers may be unwilling to agree on a contract price with a space resource firm in advance, knowing that once the new supply is on earth the spot market price will fall below the contract price. If space resource firms anticipate that their buyers have an incentive to back out of these contracts, they may be unwilling to launch mining ventures in the first place. Our research models both price risk and strategic risk incurred through investments in space mining ventures. In so doing, our research also characterizes appropriate incentives in supply contracts with such risks in mind.

Our model shows that even if the efficient scale of production at the industry level involves a mix of terrestrial and space production, individual firms may only initiate space mining under a limited set of conditions. We also describe the conditions under which such agreements are likely to break down versus remain in place, i.e., when parties are likely to find it advantageous to back out of an existing agreement. Further, we describe how such agreements will alter the composition of existing industry. We use economic models from game theory, industrial organization,

and incentive contracting in order to characterize (a) existing relevant minerals market equilibrium in terms of industry size, number of firms, quantities, prices, and profits, (b) the shift in such market equilibria under the potential entry by new space mining firms, and (c) the contract terms that are likely to produce stable prices versus terms that are likely to produce disagreement following the initiation of production

### References:

[1] Barton S. and Recht H. (2018) The Massive Prize Luring Miners to the Stars, *Bloomberg News*, 3/18/2018, <https://www.bloomberg.com/graphics/2018-asteroid-mining/>.