The Midas Touch: Operational Flexibility and Financial Hedging in the Gold Mining Industry

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Introduction – One of the most critical and prevalent risks to a company's financial performance is commodity price risk (PricewaterhouseCoopers, 2009). High volatility in input prices precludes long-term planning and increases the probability of a firm experiencing financial distress. Unfortunately, volatility in commodity prices across the board has become more pronounced over the last few decades: since 1997, the prices of many commodities have increased by up to 60% over periods of just three to six months (Agarwal et al., 2013). In order to reduce their exposure to risks associated with large, rapid changes in commodity prices, companies have several tools and strategies they can employ. Two of the most prominent strategies include financial hedging and operational flexibility.

Although hedging has received plenty of attention from the field of Finance, the subject is still nascent from an Operational perspective. Indeed, to our knowledge, there is not a single empirical paper which examines the effects of hedging on operational variables such as inventory and profit variance, even though analytical models (e.g. Gaur & Seshadri, 2005; Kouvelis et al., 2013) suggest that these relationships are profound and intricate. On the other hand, operational flexibility has received a great deal of attention in the Operations field. Yet, much of this literature has focused on the closely related concept of operational hedging and has, for example, primarily looked at shifting production between countries to mitigate exchange rate risk (Huchzermeier & Cohen, 1996). Here, we examine a different type of flexibility used to reduce risk associated with commodity prices. Finally, several analytical studies have examined the substitutability and complementarity between financial hedging and operational flexibility (e.g. Chod et al., 2010; Boyabatli & Toktay, 2006).

In this paper, we empirically test several of the propositions and results arrived at from analytical models. Namely, we examine three research questions: 1) How do financial hedging

and operational flexibility affect inventory, 2) how do they affect profit variance, and 3) are financial hedging and operational flexibility substitutes or complements?

Methodology – We examine the financial hedging and operational flexibility decisions of firms in the North American gold mining industry, companies facing substantial price risk from the international gold market. This industry is unique in that it offers a transparent, detailed look at hedging at the firm level. The quarterly hedge books (in troy ounces) of gold companies worldwide have been compiled since 2003 in collaboration between Haliburton Mineral Services, VM Group, and ABN AMRO Bank and cover the intricate details of the hedging programs of 113 companies (which account for 69% of global gold production).

In addition to using financial instruments, gold miners also have the ability to reduce exposure to price risk through their operational flexibility. In a process known as "high grading," companies strategically mine and process ore with a higher gold per ton ratio. Lower grade ores have much lower gold to waste ratios, and processing this ore incurs high production costs. By high-grading, firms actively process ore containing relatively high levels of gold and lower their production costs. By dynamically adjusting the grade of gold mined, miners can reduce their exposure to adverse price movements. We capture operational flexibility by going through all firm quarterly statements and extracting the grade of gold mined and processed by each of the companies' mines. This variance in gold grades allows us to measure the flexibility of each company.

Results - Descriptive statistics show that 39 companies (60.0%) hedged gold in at least one quarter. The mean amount hedged per company per quarter was 107,460.4 oz (almost 6,720 pounds). Companies had averages of $377.9m in revenue, $202.1m in COGS, and $227.3m in inventories every quarter. We test the effects of hedging policies longitudinally by specifying a

Feasible Generalized Least Squares model; this takes both heteroskedasticity and autocorrelation of the errors into account.

We first examine the use of financial hedging and operational flexibility as complementary or substitutable strategies. We find that these strategies tend to be substitutable: the greater the operational flexibility of the company, the less the extent of financial hedging undertaken, and vice versa. This suggests that companies which are *able* to process different grades (either because they have more mines or the ore which they mine has a higher variety of ore grades) forego financial hedging; those companies which are not flexible, on the other hand, choose to reduce risk through financial means.

However, in subsequent tests we find significant interaction effects of financial hedging and operational flexibility on inventory. Namely, interacting hedging and flexibility is associated with a significant reduction in inventory (β = -0.001788; p = 0.07). These results suggest that, in fact, financial hedging and operational flexibility can (and should) be used as complements. We do not find statistically significant evidence that financial hedging and operational flexibility reduce variance in profits.

Conclusion – By leveraging a unique dataset on the financial hedging activities of North American gold miners, we empirically test the relationships between financial hedging and operational flexibility, and of those with inventory and profit variance. We find significant results that although they are used as substitutes in practice, the two strategies should be used in a complementary manner. Additionally, empirical results show that hedging and flexibility can be used to reduce inventory.

References –

Agarwal, S., Raghavan, K., Ofori, J., & Mandare, P. (2013). *Managing extreme price volatility: How to reduce the impact of short-term changes in commodity prices using "out-of-the-money" call options.* Deloitte Consulting LLC.

Boyabatli, O. & Toktay, L. B. (2006). The interaction of technology choice and financial risk management: An integrated risk management perspective. Working paper, INSEAD, Fontainebleau, France.

Chod, J., Rudi, N., & Van Mieghem, J. A. (2010). Operational flexibility and financial hedigng: Complements or substitutes? *Management Science, 56*(6), 1030-1045.

Gaur, V., & Seshadri, S. (2005). Hedging inventory risk through market instruments. *Manufacturing & Service Operations Management, 7*(2), 103-120.

Huchzermeier, A., & Cohen, M. A. (1996). Valuing operational flexibility under exchange rate risk. *Operations Research, 44*(1), 100-113.

Kouvelis, P., Li, R., & Ding, Q. (2013). Managing storable commodity risks: The role of inventory and financial hedge. *Manufacturing & Service Operations Management, 15*(3), 507-521.

PricewaterhouseCoopers. (2009). *Navigation: Managing commodity risk through market uncertainty.* PricewaterhouseCoopers LLC.