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Portfolio of Strategies for Optimal Procurement of Platinum Group Metals (PGM) in the Automotive Industry
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Portfolio of Strategies for Optimal Procurement of Platinum Group Metals (PGM) in the Automotive Industry

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Summary: This thesis studies the optimal procurement strategy for platinum under the price and production uncertainty. Different types of supplier contracts, financial hedging strategies and spot market procurement constitute the portfolio of strategies. This project developed a Monte Carlo simulation model to analyze the benefits of using a portfolio of strategies over the baseline under various scenarios.

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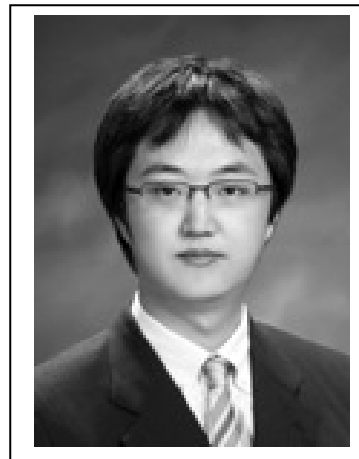
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KEY INSIGHTS

1. In no case, a 100% quantity inflexible contract is the optimal way to procure platinum. A mix of ~60% quantity inflexible, ~20 quantity flexible and ~20 spot / financial hedging procurement is observed idea across scenarios.

2. Under production uncertainty quantity flexible supply contract allows the firm to reduce inventory holding cost and total amount of platinum purchased.

3. Depending on the growth and volatility in the spot market, the expected profit/loss and its implied risk for financial hedging strategy varies.

Introduction

The recent dramatic increase in platinum prices has added substantial costs to the automobile industry. There are several challenging issues that add to the complexity in the hedging strategy for platinum.

Price volatility – High price volatility makes it difficult to use a financial hedging strategy.

Production uncertainty – There is strong correlation between vehicle demand and platinum price. This discourages automotive industry from making capital investment in platinum and keeping it for long-term.

Supply restriction – More than 75% of the platinum is mined in a single country, i.e., South Africa. Challenges such as industrial unrest and safety-related stoppages make it difficult for major mining companies in this region to increase their capacity in the foreseeable future.

This thesis studies the optimal procurement strategy under the price and production uncertainty. Many previous papers have focused on solving problems under the deterministic demand assumption or limited market access. But this study incorporates different types of supplier contracts, financial hedging strategies and spot market procurement. In order to measure the expected benefit or loss over baseline, from using a portfolio of strategies under various scenarios, the Monte Carlo simulation model was used. This mathematical framework will provide the automotive industry with a tool to analyze the benefit of having different supplier contract conditions and hedging strategies over the planning horizon.

Basic Assumptions and Simulation Framework

This thesis looks at two types of supplier contracts – Quantity Inflexible Supplier Contract (QISC) and Quantity Flexible Supplier Contract (QFC). For QISC, the company receives a discount of 7% over the spot price but the company is forced to buy a fixed quantity every month, irrespective of the vehicle demand. For QFC, the company receives a discount of 4% over the spot price but can buy 20% lower (LL) or 20% higher (UL) than the quantity every month.

The volumes contracted by QISC and QFC are based on the company's market expectation of platinum demand for automotive production for the next 5 years.

The spot market is assumed to be always available and the model also assumes that the spot market is insensitive to the company's market intervention.

Baseline contract is assumed to be a 100% QISC (100% of market expected platinum demand) at a 7% discount over spot price and spot market is always available.

The simulation model needs a set of inputs – policy inputs (specifics of the contract), engineering inputs (average platinum per vehicle) and historic information on vehicle production and platinum prices – in order to simulate the scenarios.

The simulation model has the flexibility to change all these values. Spot market availability can be turned on / off or can be made available 50% of the time.

The simulation model looks at a 5-year planning horizon and each simulation run is 500 iterations. All the results mentioned below are on an expected basis.

Portfolio of Strategies with Supplier Contracts

In this thesis, several scenarios were analyzed and costs of a portfolio of strategies approach and baseline contract were compared. The scenarios that were looked into were different variabilities in vehicle demand and spot price (0.01%, 20%, 40%, 50%, 80%, 100%, 120%, 150%), actual market trend (2006-2010 historic trend, positive 8% growth year on year, negative 8% growth year on year), market expectation (positive 8% growth and negative 8% growth year on year), selling of excess inventory (at the end of every year, at the end of 5 years) at a 15% penalty over the price (spot price, 12 month average price).

The thesis also looked at the minimum discount QFC should offer for a given set of input conditions to make it worthwhile for the company to use QFC in the portfolio.

Results

Under each of these scenarios, the simulation model varied QISC and QFC from 0% to 100% and the benefits over baseline is populated into a table as in **Figure 1**.

The shading is relative to the benefits and the lowest benefit is red (bottom right corner) and the highest benefit is green (diagonally from bottom left to top right). The colors transition from red to green via yellow (lighter shade). In **Figure 1**, the right bottom corner is in red and the top left corner is in yellow. In the middle, where there was a higher benefit, a green was given.

In **Figure 1**, the effect of actual market trend on the over benefit of portfolio of strategies under a low variability of 50% is depicted. In the first table (Scenario 1), when the actual market trend was similar to the 2006-10 trend, results show that ~70% QISC and ~20% QFC is an optimal mix, leaving 10% for the spot market or for a financial hedging strategy. In the second table (Scenario 2), when market expectation was bang on the money, the results show that ~90% QISC and the rest in spot market or financial hedging is an optimum way of platinum procurement. In the last table (Scenario 3), when the actual market trend is opposite the market expectation, the model proposes to use less of QISC (~40%), more of QFC (~30%) and leave the rest for the spot market or financial hedging.
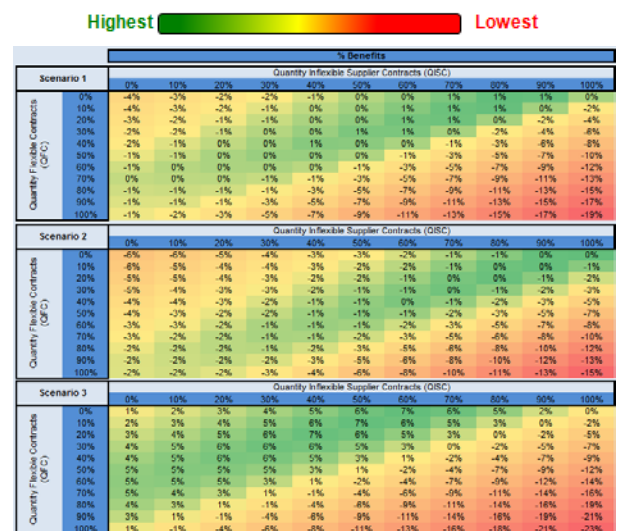

Figure 1: Scenario analysis for QISC and QFC

Based on the company's decision of when to sell the excess inventory, benefit of portfolio of strategies vary as shown in **Figure 2**. If excess inventory is sold at the end of every year, benefit of portfolio is strategies is in the range of ~4% and if the excess inventory is sold once every 5 years, the benefit is in the range of ~20%.

For various reasons, it might not be feasible to sell the excess inventory at the end of every year or can only happen with heavy losses. The company might want to wait for a favorable time. Hence the likely benefit of portfolio of strategies, intuitively speaking, should lie in the shaded region in **Figure 2**. Also what can be observed is that the benefit decreases at a faster pace when QISC is over 50% in this scenario considered.
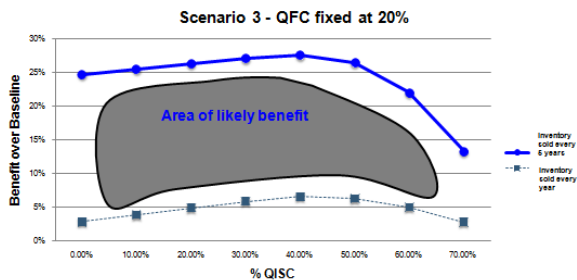

Figure 2: Closer look at benefits based on when excess inventory is sold

In order to test the robustness of using ~20% QFC for platinum procurement, the performance of 20% QFC under 9 different scenarios – that varied in market trend (historical, positive, negative) and variability (low, neutral, high) – were analyzed. As can be seen in **Figure 3**, the best portfolio of strategies was found to be in the QFC 20% to 30% region, irrespective of the scenarios. **Figure 3** uses a 50% QISC. This was verified for other values of QISC as well.
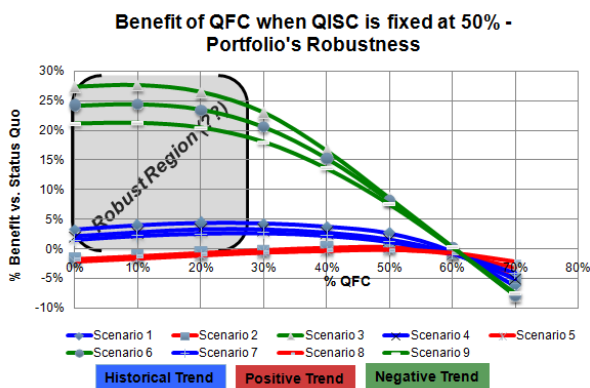

Figure 3: Robustness of using ~20% QFC across scenarios

Portfolio of strategies with Financial Hedging
Financial hedging strategies using futures and options are widely used in commodity markets such as oil, copper and agricultural products. This allows a firm to better cope with the price fluctuation of the underlying assets. In this thesis, what was considered is the long position in futures and call options to reduce the upside risks of the price of platinum.

Every month, once the platinum is taken delivery from QISC, the minimum variance hedging ratio is calculated to determine the number of futures and options contract to be purchased against the volume delivered.

Here, five different hedging strategies, using combinations of futures and options, were looked into.
1. Only Futures: Only futures are used to hedge against the underlying asset's price increase.
2. Futures contract with Maximum Loss Limitation: Maximum loss % is incorporated. If the futures price goes down more than this % it is sold off before its maturity.
3. Only Options: Only options are used to hedge against the underlying asset's price increase.
4. Futures & Options 1: Hedge using Futures, but in case that the spot price comes into certain predetermined price range, the company buys the Options instead of futures.
5. Futures & Options 2: Whenever the spot price increases more than a certain percentage, the company buys the options instead of futures.

Since the outcome of financial hedging strategies is very sensitive to the spot price movement, the above 5 scenarios were analyzed against 4 different spot price scenarios. The 4 spot price scenarios were historical trend, upward trend, static movement and slight downward trend. Since the platinum price is not expected to go down in the near future, the dramatic downwards trend were excluded from the analysis. The trends were controlled by parameters in the geometric Brownian motion. For each case a simulation of 500 iterations were run.

#	Description	Mu	Sigma
1	Historical Spot & Futures Price		
2	Upwards Trend (based on historical trend)	0.0103	0.642
3	Static Movement	0.002	0.04
4	Slight Downwards Trend	-0.001	0.05

Figure 4: Spot Price scenarios

Results
Under historical spot price scenario, the model showed that the firm could have potentially saved about 3% of the total platinum procurement cost, had the firm used one of the first two futures hedging strategies.

Our simulation results show that futures strategies are generally more beneficial than option strategies

especially in the growing price environment. This is because of the up-front cost the firm has to pay when it buys the call option. Also by incorporating maximum loss limit policy, together with a futures contract, the firm can reduce the risk of incurring huge losses from procurement of platinum at the time of a black swan event.

Conclusion

The thesis started with the belief that there was a set of strategies that, if used in a certain manner, could procure Platinum Group Metals at the optimal cost. This thesis introduced a type of flexibility contract and looked at a combination of inflexible contracts, flexible contracts, financial hedging and spot market procurement.

One of the main conclusions of the thesis is that 100% inflexible contract is not the optimal way to procure platinum. Based on the many different scenarios analyzed, an inflexible contract in the 40%~60% range and a flexible contract in the 20%~30% range is found to be a robust mix of supplier contracts. The remaining platinum of 10% ~40% is bought using financial hedging strategies or in the spot market. This can be visualized in the **Figure 5**. The benefit of introducing the portfolio approach ranges between 4% and 25% for all the scenarios analyzed, except for the scenarios where market expectation was bang on the money.

Figure 5: Portfolio of Strategies approach to PGM procurement based on market expectation

Financial hedging strategies entail a different type of risk, meaning it reduces the variance of the portfolio but it is still exposed to the potential loss of money from the transaction. Therefore, depending on the company's risk taking behavior, it can be actively utilized or avoided. Considering the dramatic price increase in the market, it is attractive in that it can effectively reduce the upside risk and curtail the overall procurement risks. By incorporating the maximum loss allowance the company can avoid a huge loss in case of a Black Swan event.

The benefit of using a portfolio of strategies varies significantly based on the decision of when the excess inventory is sold, value of upper and lower flexibility in QFC, discounts in QFC and uncertainty surrounding the market expectation for the next 5 years. The benefit of introducing flexible contracts is minimal if the economy is in line with market expectation. The use of a flexible contract reduces the procurement cost of platinum when facing a Black Swan type of an event.

It can also be safely assumed that the potential benefit of using a portfolio of strategies along with financial hedging will be higher as the benefits from this simulation model are clouded by the strong assumption made o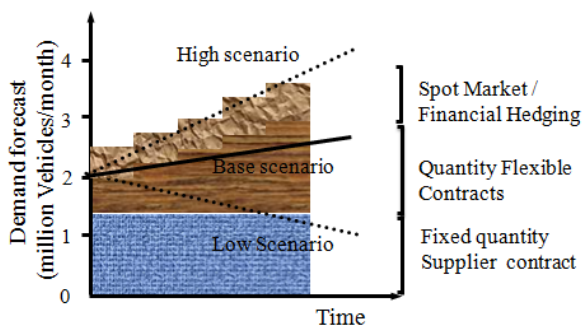n spot market reaction to the company's intervention.