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Optimal Sourcing Strategies for Managing Supply Chain Risk for Platinum Group Metals (PGM) in Automotive Catalytic
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Optimal Sourcing Strategies for Managing Supply Chain Risk for Platinum Group Metals (PGM) in Automotive Catalytic

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Summary:
This thesis focuses on two major questions. First, what is the value of implementing a hedging strategy to minimize the risk implied in the procurement of price volatile raw materials? Second, under what circumstances can a hedging strategy, such as entering a long position in the financial markets, be exploited such that in the long run the expected benefits outweigh the losses? To evaluate the above two points, a Monte Carlo Simulation is developed and applied to compute total procurement cost for scenario with and without hedging.

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KEY INSIGHTS

1. Futures contracts present opportunities for reduction in the total procurement cost of price volatile raw materials.
2. The hedging strategy should be coupled with a sourcing strategy where a portion of the forecasted PGM is sourced using long term contracts and the rest is purchased on the spot physical market.

Introduction

The ultimate goal of procurement is to have raw materials available, when required, at the lowest possible cost and at a desired quality. Unfortunately, in today's globalized markets, uncertainties in customer demand, supply availability and supply cost make this goal highly challenging. Furthermore, in situations where the raw materials procured, e.g. platinum group metals, have a highly volatile price, the challenge is even greater.

Traditionally, automakers have relied on long term supply contracts to avoid or reduce the risks related to demand uncertainty and supply availability of Platinum Group Metals. However, in the case of these metals, price changes are very likely, and although these agreements address supply availability they do not address supply cost variability. Thus, automakers end up with the risk of price changes. For example in 2001, there was immense speculation around supply shortages of palladium in Russia. In response, Ford Motor Co. proactively entered into a binding contract for large quantities of palladium at a price of $1094 per ounce. However, demand began to fall throughout 2001. Meanwhile, contrary to initial speculation, supply of the metal went up. Russia started to stabilize its production while South Africa, another big supplier, increased production. The combination of increased supply and decreased demand drove the price of palladium down by almost 65%, to around $400 per ounce at the beginning of 2002. To add to the pain, Ford's Research and Development department announced that they had found new ways to decrease the quantity of palladium required per car. At the end of the fiscal year, Ford revalued their inventory at $440 per ounce and wrote-off $1 billion in losses.

One reason why supply cost variability was kept outside of procurement planning in the past was the limited availability of information. However, with recent technological advances, this is no longer a constraint. In fact, advances in information technologies have made it possible to effectively trade more commodities (such as Platinum Group Metals) in exchange markets.

In the past few years, trading commodities in exchange markets has become a common practice. This gives procurement managers the opportunity to add more flexibility to their supply chains since they can now use spot procurement as an alternative to relying upon procurement through fixed supply contracts. Also, futures markets allow locking the

price of raw material for a determined time period through financial mechanisms (usually referred to as hedging). This also serves as a source of price discovery since these exchange markets inherently operate under the forces of supply and demand.

In this thesis, a model that includes the above mentioned variables is proposed and evaluated. Besides accounting for demand uncertainty and price variability, the simulation model proposed measures the benefits and risks involved with adopting a procurement strategy that includes financial mechanisms such as future contracts. The results obtained by this strategy are measured and compared against a procurement strategy that does not use such financial mechanisms. The two strategies, hedging vs. no hedging, were evaluated based on the corresponding total cost incurred during the duration of a supplier contract. The model also evaluates the robustness of the expected total cost of both strategies while adopting different sourcing scenarios, e.g., 80% of the forecasted PGM's procured through a supplier contract and 20% bought in the spot physical market.

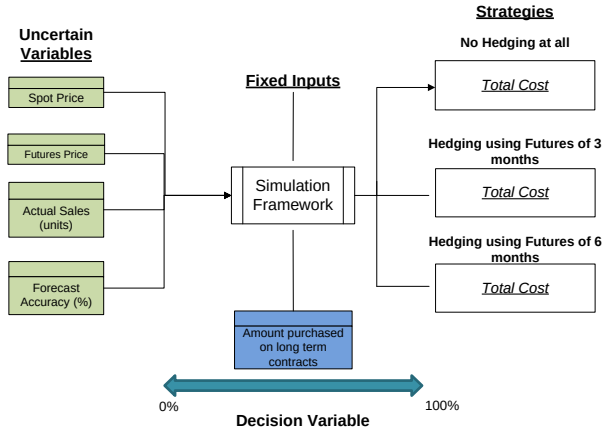
Simulation Framework

The baseline situation approached in the thesis is an automaker that uses long term quantity contracts with their suppliers to guarantee secure delivery of PGM. In return the automaker obtains certain discounts over the spot price at time of delivery and some flexibility on the quantities ordered. The contract duration is [0, T], and quantities are ordered once per period *t* and are delivered once per period *t*. In addition, the decision maker will like to evaluate the benefits of entering a long position by buying and selling futures in the exchange of futures markets as a way to hedge against the price volatility.

Two basic procurement strategies, hedging vs. no hedging, will be compared and analyzed by varying uncertain variables. The purpose of the simulation model and of this study is not to search for optimality on the quantities ordered or the optimal financial hedging strategies. The objective is to evaluate the robustness of the results of these two different basic strategies under different circumstances.

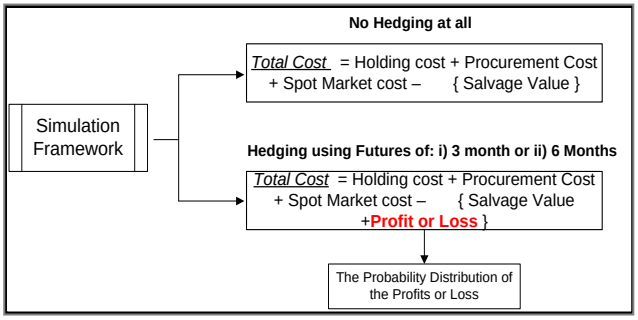
The uncertain variables considered are: i) the spot price of the PGM, ii) the futures prices of PGM, iii) Forecast Accuracy, iv) Actual sales (demand of vehicles). Historical data was used to model the uncertain variables.

The decision variable in the model is how much to buy from the supplier (using the long term contracts) and how much to buy on the spot physical market to satisfy the forecasted PGM requirements. The decision variable is "Amount purchased on long term contracts". If this variable is 60% then by default the amount purchased on the spot physical market is 40%.



Model Development

The model was developed using Microsoft Excel, and the software used to generate the random variables and then simulate is @Risk. Since the purpose of the model is to compare two basic strategies, no hedging vs. hedging, the simulation model calculates the Total Cost for both strategies. This cost is calculated for the duration of the contract [0, T]. For the hedging strategy, the probability of profit or loss is plotted as a histogram or a cumulative function.



Depending on the values of the spot price and futures price generated, there will be an expected profit if the futures price at which the contract was entered in time *t* is lower than the future price at which the contract is sold in time *t+3* or *t+6* for 6 month contracts. On the other hand, if the futures price at which the contract was entered in time *t* is higher than the future price at which the contract is sold in time *t+3* or *t+6* for 6 month contracts here will be an expected loss.

Numerical Experiments

Numerical experiments were run for a supplier contract with a timeframe of 60 months, i.e., the contract duration is [0, 60]. The simulation was

customized and designed for platinum. Each time the simulation was run, the uncertain variables were generated 500 times and the total cost for both, the hedging and no hedging, was calculated and recorded.

Eight different scenarios were evaluated with the simulation model. For the two conditions of the variable actual sales, 4 different situations of forecast accuracy were generated: *a positively biased forecast, a forecast with a mean around 100% of accuracy, a negatively biased forecast and a perfect information scenario*. These four different situations were chosen with the objective of analyzing and understanding the behavior of the hedging strategies as the financial instrument (future contracts) uses the forecasts as inputs.

Scenario	Variable and Trend	Variable and Value
1	Increasing trend in Actual Sales	Forecast Accuracy μ = 120% and σ = 20%
2	Increasing trend in Actual Sales	Forecast Accuracy μ = 100% and σ = 20%
3	Increasing trend in Actual Sales	Forecast Accuracy μ = 80% and σ = 20%
4	Increasing trend in Actual Sales	Forecast Accuracy μ = 100% and σ = 0%
5	Decreasing trend in Actual Sales	Forecast Accuracy μ = 120% and σ = 20%
6	Decreasing trend in Actual Sales	Forecast Accuracy μ = 100% and σ = 20%
7	Decreasing trend in Actual Sales	Forecast Accuracy μ = 80% and σ = 20%
8	Decreasing trend in Actual Sales	Forecast Accuracy μ = 100% and σ = 0%

Results

In the eight scenarios evaluated, the total cost achieved in the strategy of Hedging using 3 month futures contracts is less than the total cost obtained in the strategy of No hedging. This happen because in each of these scenarios the total cost in the hedging strategy is reduced by adding the expected profit obtained by trading futures contracts.

However, if there is an increasing trend in the Actual sales, the expected profit and the probability of having profit are greater than if there is a decreasing trend in Actual Sales.

Regardless of the trend in Actual Sales, the hedging strategy has better results when the forecast is positively biased. In scenarios 1 and 5 have the highest expected profit, respectively in increasing and decreasing trend of Actual Sales. This happens because the hedged quantities are calculated based on the forecasted future requirements of PGMs, thus, if the forecasts are positively biased then the amount traded in the financial hedging is upscaled too.

Regarding the sourcing strategies (represented by the decision variable), if the forecast is positively biased (for example, scenarios 1 and 5) then the minimal cost is achieved by procuring 60% using the long term contracts. On the other hand, if the forecasts are negatively biased (scenarios 3 and 7) then the sourcing strategy that achieves the minimal total cost is by procuring 100% using the long term contracts.

In the eight scenarios evaluated, the minimal cost was never achieved by procuring 100% of the forecasted amount on the spot physical market, this happened in both the hedging and without hedging strategy. This result shows that the discount over spot price (benefit in the long term contracts) moves the optimal solution toward a sourcing combination where a percentage of the required PGMs is procured using long term contracts.

Conclusions

Regardless of the trend in actual sales, the hedging strategy analyzed presents opportunities for cost reduction. To achieve this, the hedging strategy should be coupled with a sourcing strategy where a portion (60%-80%) of the forecasted PGM is sourced using long term contracts and the rest (40%-20%) is purchased on the spot physical market. With such a hybrid strategy, the total cost associated with the procurement of PGM can reach results that are comparable to the ones obtained under the “perfect information” scenario, where the forecast is 100% accurate.

Even a company whose core business is not in trading financial instruments can safely hedge itself against the price volatility of platinum by adopting 3-month long futures contracts. This strategy is beneficial as there is less room for speculation on the futures prices of the underlying commodity; thus, the risk of losing money is lower than the case of “going long” in the futures markets.

The spot physical market provides the manufacturer an alternative source of supply. It offers the advantage of immediate delivery of material in case the demand is greater than anticipated. It also allows the manufacturer to sell its excess inventory in case of an economic recession. Overall, the spot market gives the manufacturer greater flexibility compared to the traditional, lengthy supply contracts.

By observing the behavior of an unknown sample of buyers and sellers auctioning for the commodity, a participant can gain valuable information about the commodity’s future prices. in the futures trading markets. At least, the information that can be obtained is likely to be better than internal company’s forecast.

One of the inputs to the hedging strategy developed in this research is the forecast of the amount of PGM needed in the future. It is seen that higher profits can be expected in scenarios where the forecast is, on an average, biased towards overestimation that the scenarios where the forecast is biased towards underestimation.