A Real Options Approach to Manage Flexible Contracts in the Telecommunication Networking Industry

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Introduction

One of the biggest challenges facing Original Equipment Manufacturers (OEMs) and Electronic Manufacturing Services (EMS) providers in the telecommunication networking industry is to predict the spending patterns of the telecommunication service providers due to uncertainties in the economy, intense competition, short product life cycle in the industry and many other factors. While studies over the years have focused on optimizing the expected profits by minimizing the risk of excess inventory, companies are also unwilling to forgo profits on unmet demand. This is especially so in a market that is worth well over $100 billion even during the economic down-turn. Including the cost of damaged relationships and future market opportunities, the cost of lost sales can be very significant in the increasingly competitive market.

The thesis explored the use of real options to enable a telecommunication networking company to structure their supply chain so as to better exploit the upside opportunities when actual customer demand significantly exceed forecasted demand and actual demand can only be confirmed when the delivery lead-time is less than the normal supply lead-time.

Real Options Model

The thesis sets forth a framework for developing real options analysis and evaluated three approaches against the current supply contract between the OEM and EMS provider. The aim is to explore the possibilities of instituting real options in existing contracts in order to maximize profits given the uncertain demand environment. With uncertainties in demand, sales and backorder delivery lead-time, the models developed are based on balancing production quantities and holding of finished goods inventories to study the impact of sudden surge in demand on the Company’s net profit over the product lifetime.

The idea is to establish a long term contract that meets the defined fraction of expected demand derived from consensual forecast, coupled with short term flexible options contract that have higher unit prices but guaranteed availability to cover short term fluctuations. The real options model studied to expand the company’s resources in times of surge demand are as follows:

a. Fixed Production Model. The first model targets a fixed production quantity based on the average projected annual demand. While the annual, quarterly and monthly consensus demand forecasts will continue to be provided by the OEM as part of the quantity flexible contract, the surplus between the production and forecasted quantities will serve as option units.
b. **Fixed Percentage Excess over Forecast Model.** The second model is based on having a structured agreement with the EMS provider to produce more than the consensual demand forecast every month. The excess quantity to be produced, which serves as the option quantity, will be based on a fixed percentage over the monthly consensual demand forecast.

c. **Safety Stock Model.** The third model is to buffer the maximum possible surge demand as safety stock i.e. the options quantity is the safety stock. The safety stock is derived from past demand data of similar products in the company’s portfolio based on the consensual assessment of the prevailing economic situation.

The profits of the various models are then computed using Excel spreadsheets. By using Monte Carlo simulation to replicate the uncertainties in the demand, sales and backorder delivery lead-time over many cycles, the probability distribution function of the identified uncertainties defines the probability distribution of the net profit of each model. This is then repeated by varying the number of main assembly and key components to be planned as option units for the month to find the highest profit possible for each of the model.

**Results of Simulation**

The results of the simulation for the 3 models are shown in Figure 1. The models offer value when the company engages in options contract with the EMS provider over the product lifecycle. However, the number of options units is small for both the main assembly and the key component. As the number of agreed option quantities increases, the value of the option contract decreases. This is especially true for the number of main assembly due to its higher cost.

![Figure 1 – Net Value of Options Contract for the Established Models](image)

**Table 1 – Parameters Resulting in Highest Option Value in the Simulation**

<table>
<thead>
<tr>
<th></th>
<th>Fixed Production</th>
<th>Fixed Percentage Excess over Forecast</th>
<th>Safety Stock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Assembly</td>
<td>1 unit</td>
<td>5% over forecast</td>
<td>1 unit</td>
</tr>
<tr>
<td>Key Component</td>
<td>1 unit</td>
<td>0% over forecast</td>
<td>0 unit</td>
</tr>
</tbody>
</table>
Sensitivity Analysis of Simulation Result

a. **Option Price vis-à-vis Strike Price.** The effect of the option price vis-à-vis strike price for each of the three models were simulated by varying option price and strike price as a percentage of the wholesale price. By understanding the relationship between the option and strike prices, it will facilitate the negotiation of contract with the EMS providers. The resulting graphs are shown in Figure 2.

![Figure 2 - Sensitivity of the Models to Option vs Strike Price](image)

b. **Cost of Lost Sales.** Because the number of lost sales significantly affects the overall profitability of the company, it was important to understand the impact of the cost of lost sales when considering having options to hedge against surged demand. By fixing the option parameters and the various prices, the effects of the cost of lost sales on the value of the option models is derived as Figure 3.

![Figure 3 – Sensitivity of Option Models to the Cost of Lost Sales](image)

c. **Salvage Value.** The salvage value of the product changes the effects of inventories on the overall profit of the current system. It is therefore important to understand the effects of the salvage value on the value of the option. Figure 4 shows the results from the simulation.
Summary of Results and Analysis

a. Options Contracts Offer Higher Value. Establishing options contracts to hedge against possible surges in demand provides greater value than simply forecasting the future demand when companies are faced with uncertain stochastic customer demand. Amongst the 3 options approaches studied, options contract offers an average increase of 15% in value over a contract without options, with the safety stock model offering the highest value at 25% over the contract without options.

b. Higher Option Value has Higher Risks. Although the safety stock model offers the highest value amongst the 3 approaches studied, it also has the biggest spread between the maximum and minimum possible values obtained during the simulation. At the minimum, the safety stock model can cost $20K more than the fixed production model although its maximum makes $75K more. Hence, while the safety stock model offers the highest value, it also poses the greatest risk in terms of possible gains and loss.

c. Maintain a Small Number of Option Units for Spiky Stochastic Demand. The quantity of option units planned for each of the 3 models studied is small and the net value of the option decreases when the quantity of option units increases. This phenomenon is a result of the great spikes in the demand over a small duration of the product lifecycle. As a result, companies will need to balance between the number of option units to be held which will result in high options cost and negate the value of the option contract, while too few option units will not allow the company to meet the increased demand. Companies must therefore complement options contract with improved forecasting and inventory policies to better anticipate huge increases in demand.

d. Approach for Options Contract Dependent on Forecast Accuracy. In the approaches studied, the safety stock model provides the highest value. It is also the only model that is not dependent on the monthly forecast; the option units for both the fixed percentage excess over forecast and the fixed production model are a function of the monthly forecast. When the forecast for each run is varied, the fixed percentage excess over forecast model offers greater value than the other models when the forecast is able to anticipate the rise and fall in demand. This is so even when the actual forecasted numbers are not accurate.
e. **Options are Valuable Even When Total Options Cost is High.** The profitability of options contracts are quite robust to changes in the total options costs. Although the company’s product is sold at 200% of the wholesale price, the value of the option is still positive when the combined cost of the option units is 190% of the wholesale price. This is because the cost of lost sales affects the overall value of the options contract more than the other cost components of the supply chain. It is however noted that the option value is sensitive to the option price as opposed to strike price established in the contract.

f. **Cost of Lost Sales is an Important Factor Affecting the Value of Options.** The cost of lost sales greatly impacts the value of the option. Lost Sales occur when a customer responds to an out-of-stock situation by canceling the demand. When the cost of lost sales is low, the value of the options contract can be negative. However the net value of the options increases with the cost of lost sales. Companies must therefore carefully consider the actual cost of lost sales when evaluating options contract. Besides losing the gross profit margin, the loss may extend beyond the margin on the product which is actually out of stock. Some of the common components of lost sale include profits from possible after-sales service and maintenance, profits from sales of complementary products/accessories, costs of marketing and advertisements etc. Other components which are difficult to estimate include cost of lost customer and the “ill will” that may be caused as a result of the out-of-stock situation. Under-estimating the “true” cost of lost sales may result in companies mistakenly concluding the value of options contracts.

g. **Increase Salvage Value to Increase Value of Option.** The salvage value of a product will inevitably increase the net profit of a contract. Any unused option units having a higher salvage value increases the net profit of the contract. Hence, companies involved in options contracts should consider modularizing their products such that most, if not all, of the components can be salvaged for other uses.

**Recommendations**

All the three options models explored offered higher value than the model with no options. The company will do well to consider establishing options in their contract with the EMS providers. And while the safety stock model offers the highest return with a manageable spread as compared to the other models, its adoption depends on the risk profile of the company concerned. Given the highly stochastic and spiky nature of the demand, it is undesirable to cater too many units in the option. In addition, the company will need to complement options contract with good forecasting and inventory policies. In considering the value of the option, the company should be willing to compromise on the strike price, to bargain for a good option price. To improve its bargaining position, the company can consider designing the product such that its increases its salvage value if it is not sold. In addition, the company must take into account the potential cost of lost sales. Given that the company offers a very broad range of telecommunication products, involves itself in maintaining the equipment and provides after-sales services for the equipment that it sells, the cost of lost sales to the company is likely to be high and needs to be carefully considered. If it is indeed the case, the company will benefit significantly from the establishment of options contract with its EMS provider.