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Application of Real Options Analysis in Commercial Aircraft Manufacturing: Evidence from Japan

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Introduction

Real Options Analysis (ROA) is one of the most widely used investment valuation techniques. It is different from NPV (Net Present Value) in the sense that it accommodates the flexibility in decision-making. For many large-scale investments, the returns cannot be achieved until after so long time and return value also is uncertain. The aviation industry is a highly capital-intensive industry. The costs of Research and Development (R&D) are quite high in this industry and the returns are slow and uncertain in nature. Japan used to have a great industrial landscape for the aviation sector during the Second World War II but it has stopped all on a sudden after the War. Since then, the aviation industry in Japan has not heard any great news about making a return. But things have got a new height with the introduction of Mitsubishi Regional Jet (MRJ) in 2015.

Literature Review

In the world of finance, there are many techniques to evaluate the prospect of investment and recommendation strategies. Among all the techniques available, NPV is one of the most often utilized techniques by firms as well as experts all over the world. It is determined by discounting all arising cash flows (at some internal rate of return) to the start time of the project and thus it can truly be regarded as the 'cash equivalent' of undertaking the project [5].

Using NPV for project evaluation is more like taking decisions in a binary manner. The rule is to accept an investment project if the NPV has a positive value and reject the project if it yields a negative value. But basically, NPV systematically undermines the value of the project. In other words, NPV does not care about the future prospect of the project into consideration. A project might look not so good at first sight but that does not mean it will be same all the time. Time and circumstances can change hence the prospect of any projects also can change. Then NPV can be considered to almost always lack the flexibility for decision making.

In order to cover up the lacking of NPV, another technique has come up in the world of finance namely the real options approach. Real options analysis (ROA) has emerged during the 80's and this technique is highly suitable for projects with high uncertainty. Unlike NPV, it provides flexibility in decision making. Real options analysis can rightly help to adopt decisions in response to unexpected market developments [1].

The foundation of real options lies within the framework of financial options (Lucius, 2001?). While financial options are more precisely applied to financial assets, real options are reserved for real assets. A real option is the right to undertake a certain business-related action.

On the other hand, the business of aviation is a highly volatile one. The amount of investment is quite high in this sector but the returns are quite arrhythmic in nature. Considering all of these, real options analysis can be recommended for this sector as one of the decision tools. Even though there are many kinds of literature exploring the applications of real options in a wide array of field, there is mysteriously a smaller number of studies pertaining to the field of aviation. A thorough review trial of pertaining literature can yield the following Table 3 enlisting the recent studies in the area of aviation where real options have been applied.

As it is evident from the above Table 1, there is a potential study gap of real options analysis in the case of aircraft manufacturing particularly in the context of Japan.

Table 1: Recent Studies Pertaining to the Application of Real Options in Aviation

Research	Area
(Miller, 2010)[3]	Parts manufacturing approval (PMA) license for an aerospace firm.
(Rodger, 2013)[4]	Aerospace revenue
(Hu & Zhang, 2015)[2]	Aircraft acquisition by airlines
(Xiao, Fu, Oum, & Yan, 2017)[6]	Airport capacity

Analysis Results and Interpretation

The road towards real options analysis begins with the estimation of the DCF (Discounted Cash Flow) and then NPV. Analyzing the investment cost and cash flow of the assumption project yields a negative value from related data. So, from here we apply real options analysis for this case.

By utilizing the real options analysis tool of Monte Carlo simulation in Oracle Crystal Ball, we achieved the following four forecasts namely NPV, ENPV, Options Value, and Volatility.

After running 50,000 trials, we have achieved the following forecast for the NPV shown in Figure 1.

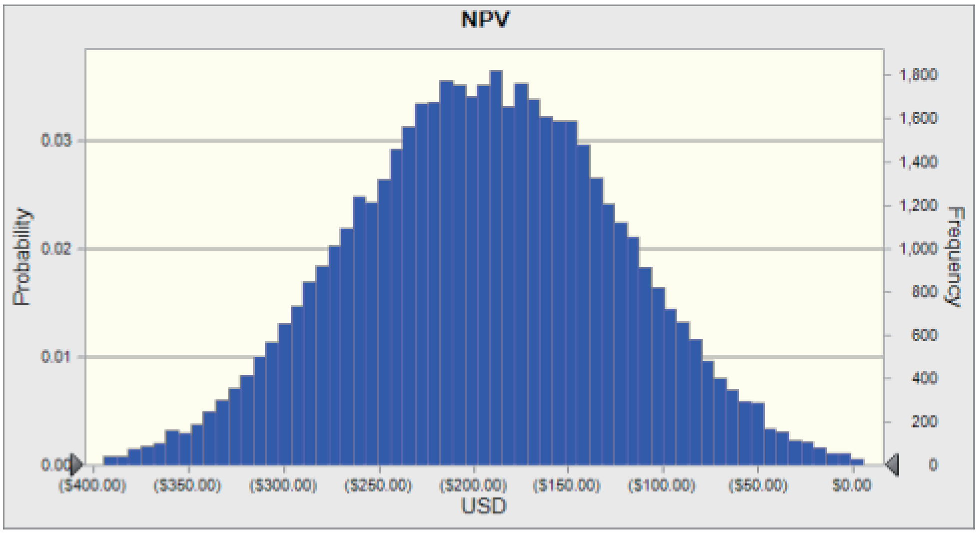

Figure 1: Forecast for NPV

In Figure 1, the base case for NPV is ($194.99) with a mean value of ($194.80). It shows that NPV for this project lies in the negative zone.

Again, after running 50,000 trials, the following forecast for ENPV (Expanded New Present Value) has been achieved based on a sequential compound option adopted here shown as Figure 2. It means the summation of NPV of the original case with option value from that option.

In Figure 2, the base case for ENPV is \$2,669.33 with a mean value of \$2,681.85. It is evident that the ENPV value lies in the positive zone. Then, we can decide to invest in this project.

Therefore, it is also possible to depict NPV, ENPV and options value through an overlay chart as Figure 3. According to contribution of option value, original negative NPV can be changed into a positive ENPV as each expected value position of NPV and ENPV. However, the standard deviation of ENPV became much bigger than that of NPV. Thus, this change can be considered as High-return and High-risk investment strategy.

Following is Figure 3 showing all these together.

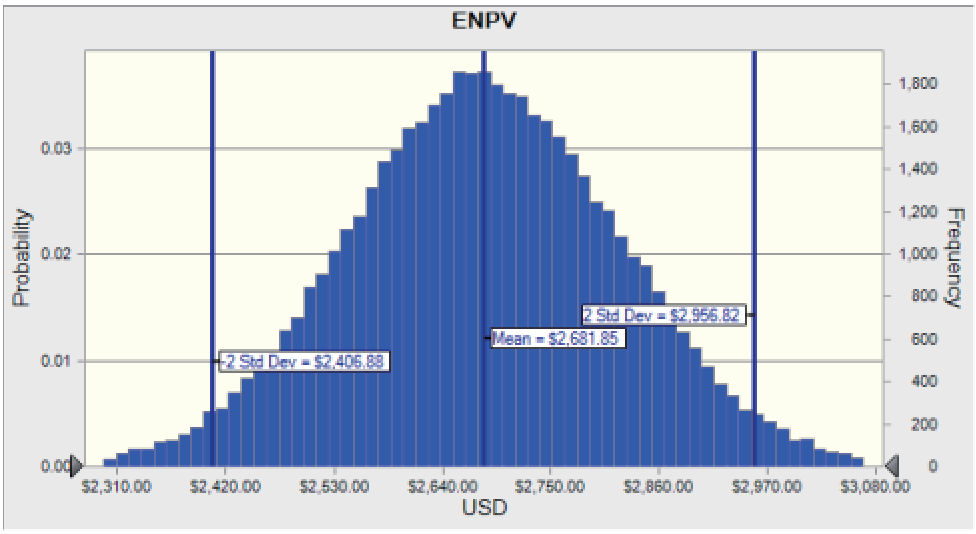

Figure 2: Forecast for ENPV

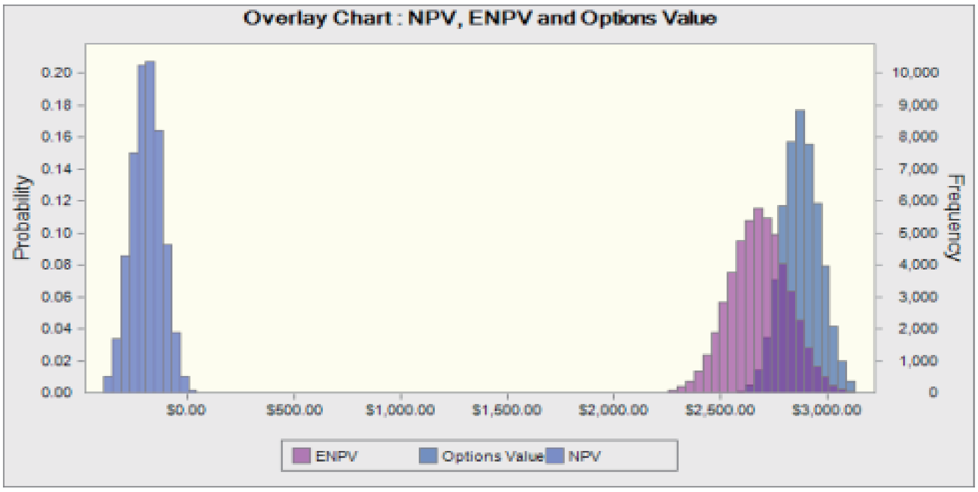

Figure 3: Overlay Chart - NPV, ENPV and Options Value

After running 50,000 trials, the following Figure 4 for the volatility of original project has been found. In Figure 3, the base case for volatility is 61.91% and this value is relatively higher.

Stochastic Optimization of Decision Variables

After Monte Carlo simulation to analyze probability distributions of NPV, ENPV, and option value, we try to apply OptQuest, stochastic optimization software for some decision variables, as direct cost ration at each fiscal year, shown as Figure 5.
In Figure 5, the objective function for the optimization has been set up to maximize the mean of ENPV. After 500 solutions, the Mean of ENPV was improved from $2,933.78 to $3,204.37, a change of 9.22%.

Conclusion

Here, we see aviation industry companies in the promising but very risky business are facing deep and long valley of death. Then we apply real options analysis to examine the possibility of change from a negative NPV to a positive ENPV as investment criteria owing to some real options as a sequential compound option. We applied Crystal Ball software of Monte Carlo simulation of real options analysis and showed the possibility of improvement of the expected value from a negative NPV to a positive ENPV. Additionally, we also applied OptQuest for stochastic optimization of some decision variables. This tool can contribute to scenario analysis. Remaining challenges are integration of real options with game theory and Bayesian MCMC.

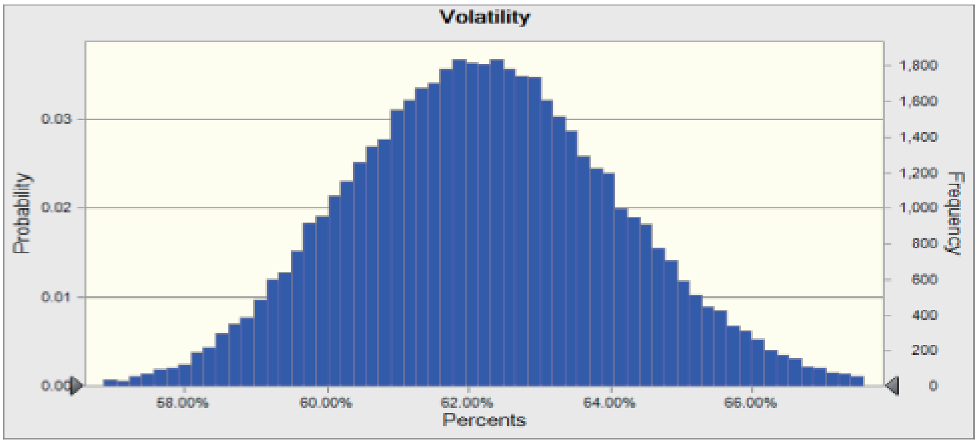

Figure 4: Forecast for Volatility

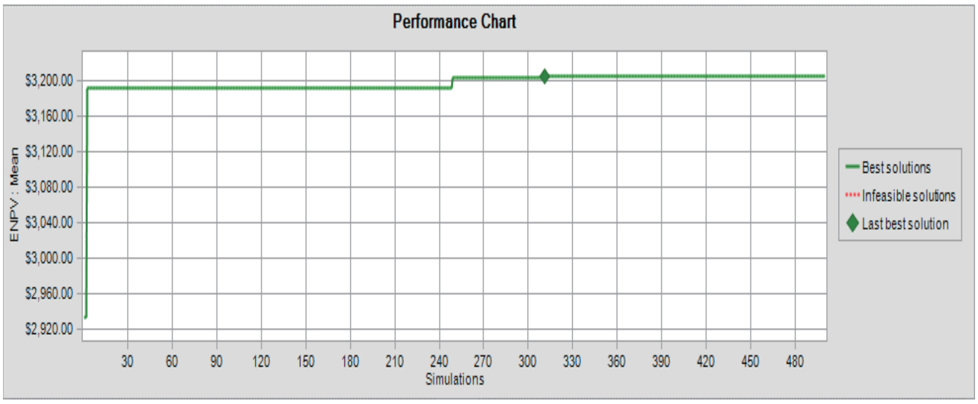

Figure 5: Optimization Graph

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