

A COMPUTER SYSTEM FOR REAL OPTION ANALYSIS OF INVESTMENT IN SHIPS

F. C. M. Pires Jr, Rio de Janeiro Federal University, Brazil
M. Rezende Filho, Gama Filho University, Brazil

SUMMARY

The paper presents the main features of a computer system for support the analysis of investment in ships, based on Real Options Analysis – ROA and Monte Carlo simulation.

ROA has been increasingly adopted for large projects, subject to high degree of uncertainty and presenting significant managerial flexibility. Despite of the recognized applicability in shipping, ROA is not normally applied, mainly because of the technical and operational complexity. The system aims at overcoming these problems, and was designed to make feasible ROA application by non-specialists.

The proposed ROA methodology for shipbuilding projects may incorporate options of abandon, defer or lay-up. The models for stochastic series of time-charter rates and ship prices, necessary for ROA, may be automatically or interactively selected. The system also allows the interactive definition of the cash flow structure, including the managerial options to be considered.

The architecture of the computer system and the user interface are discussed.

1. INTRODUCTION

The shipping markets are extremely volatile and unpredictable. Uncertainty and risk issues dominate the decision making processes related to chartering, selling, buying or building a ship. Real Options Analysis - ROA has been increasingly used in assessment of investment decisions in presence of relevant uncertainty, in most economic sector, in the last years. In these cases, there is normally some managerial flexibility, for example, to interrupt, abandon, or expand the project, during the lifespan, depending on the information made available along the operation period. On the basis of an analogy with the financial options market, the options related to these flexibilities are valued, and the value of these options is added to the project net present value (NPV). Considering the Real Options value, some projects originally negative-NPV may become positive-NPV. This approach fits better the real world investment decisions. Real Options Analysis (ROA) for some time has been considered as an efficient and modern approach to capital budgeting.

Notwithstanding the clear adherence of ROA approach to shipping sector characteristics, it is normally not so used in practice as it is in many other sectors with comparable risk level. However, ROA has recently attracted the attention of both shipping academics and practitioners.

The likely main obstacle to dissemination of ROA in ship investment is the complexity of the models, which require skilled professionals, trained in financial assessment, analysis of stochastic processes and computer simulation techniques. This is not compatible with the environment of a typical shipping company.

The main objective of the system herein presented is to overcome this problem. The computer system proposed will allow non-specialists to perform a complete Real Options Analysis, specifically for investment in ships.

2. REAL OPTIONS ANALYSIS - ROA

The ROA has emerged from an analogy with financial options. A financial option gives the owner the right to buy or sell a particular asset at a predetermined date, for an exercise price specified in the contract. To buy an option, the holder shall pay a premium to the option writer. Prize amount is directly related to the conditions of the option contract.

The existence of uncertainty and the possibility of change in the scenario until the maturity date can make the option attractive to investors. From the point of view of the options dealer, the greater the uncertainty (measured by the market volatility), the greater the profit expectation. An option contract provides loss risk limited to the premium, and unlimited earning opportunities. If at maturity, the holder chooses not to exercise, the whole loss will be the premium paid for the option. An analogous reasoning would be used for real options, as above introduced. Thus, the greater the uncertainty involved, the greater the value of the real option.

The ROA approach to analysis of investment in real assets is based on this analogy. The relevant value of an investment project will incorporate not only the expected NPV, but also the value of existing options of abandon, interrupt or expand the project in the future, like in the following expression:

NPV Expanded = expected NPV of future cash flows + value of options resulting from active management

Dixit and Pindyck (1994) demonstrated that the adoption of traditional NPV decision rule alone may lead to rejection of projects that, when analyzed by ROA, would be accepted.

ROA has been considered in the past two decades as a new paradigm for economic analysis of projects. There is a large literature in this subject. The following references can be considered classical:

- Dixit & Pindyck (1994) – this seminal work focuses on continuous time methods (differential equations) and remains the most advanced in the area;
- Trigeorgis (1996) – presents a comprehensive approach, dealing with both valuation in continuous time and discrete time, with emphasis on financial modeling;
- Amram & Kulatilaka (1999) – a simpler text oriented to practical management level, with emphasis in conceptual not mathematical discussion, and modern examples (such as investment in internet);
- Mun (2006) – presents a comparative analysis between ROA and traditional analysis of discounted cash flow.

In shipping, the ROA has a limited literature. We can mention the following works in a short bibliographic review:

- Bjerksund and Ekern (1995) – analyze the value of the option to extend a time charter contract;
- Bendall and Stent (2005) – apply real options analysis to assess a transportation investment in Southeast Asia;
- Høeg (1998) – presents a real options analysis of newbuilding contracts and suggests a methodology for estimating the ship value from the point of view of the shipowner, shipyard and brokers;
- Sødal, Koekebakker and Adland (2006) – a real options analysis for bulk carriers freight rates, presenting a model for inefficient markets;
- Handelshøyskole (2007) – a ROA for investment in LNG ships;
- Sødal, Koekebakker and Adland (2008) – present a model to estimate the value of the flexibility to operate in both bulker and tanker markets;
- Pires, Assis and Rezende Filho (2012) – a ROA model, taking the abandonment option for a tanker newbuilding, discussing the impact of the decision maker's risk attitude on option value.

Trigeorgis (1995) classifies real options according to the kind of flexibility they offer. The types of real options relevant for analyzing a ship acquisition or a shipbuilding project can be classified in the following groups:

- **Abandonment option:** the option that a shipowner or investor has to sell the ship and exit the market, during the project lifespan, if the prospects become negative;
- **Expansion option:** the option of taking a larger share of the project, if the prospects become positive;
- **Lay-up option:** the option of laying-up the ship, for some time, holding the right of deciding later to sell or to put she back in operation;
- **Deferring Option:** the flexibility the investor has for deferring the investment decision, to wait for better prospects or more information.

3. THE COMPUTER SYSTEM

3.1 SYSTEM ARCHITECTURE

The ROA approach to evaluating investment in ships is complex, so that it requires highly skilled specialists. ROA involves stochastic processes analysis, computer simulation and advanced financial mathematics.

The motivation to developing this computer system was to overcome this problem, offering to practitioners a powerful tool for ship investment appraisal. Some attributes of the proposed system are:

- Usable by non-specialists;
- Intuitive and user-friendly interface;
- Several forecasting models, allowing analysis of multiple alternative scenarios;
- Automatic simulation setup;
- Low processing time and simple hardware requirements.

The application was developed in Visual Basic 6.0, and the database was developed with Microsoft Access and Microsoft Excel 2010. The system structure is shown in Figure 1.

The system is composed by the following modules:

- Basic data;
- Market data;
- Time series models selection;
- Simulation setup and run;
- Result reports.

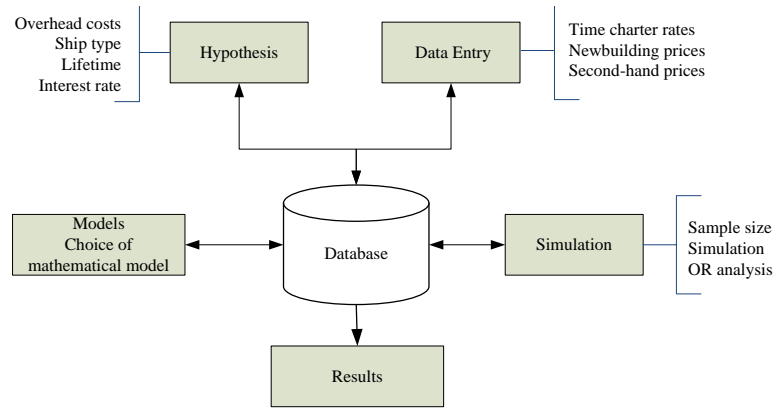


Figure 1 – System structure

3.2 BASIC DATA

This module performs the input of the basic data for project assessment, like discount rate, type of ship, useful life or the period of analysis and daily running costs (considered as deterministic). Figure 2 illustrates the interface screen

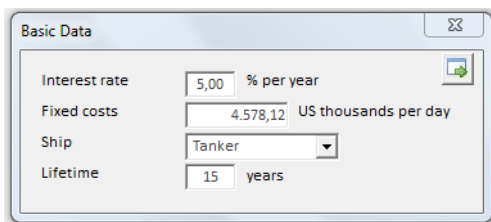


Figure 2 – Basic Data

3.2 MARKET DATA

This module allows the user to directly input the market data or import them from existing database information. The main market data are time charter rates, newbuilding and 5-year second-hand prices in the database. The second hand prices for other ages are estimated from those series.

This module allows checking and visualizing graphically the data.

Figure 3 illustrates the interface screen

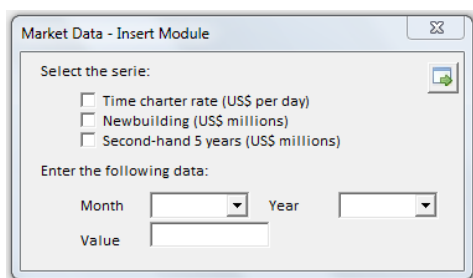


Figure 3 – Market Data

3.3 TIME SERIES MODELS SELECTION

The system has some standard time series model, which are automatically fitted to data. The user can choose the best model, considering his or her own criteria. In order to support this decision, the system shows the main time series fitting indicators, like mean square errors, correlograms and the adjusted graphs. Alternatively, the system may select automatically the model on the basis of minimum square errors. The models presently included are Exponential Smoothing, Auto Regressive Integrated Moving Average (ARIMA) and Mean Reversion. Figures 4 and 5 illustrate the interface screens.

The coefficients of correlation between the time series are estimated, in order to keep the correlation levels during the simulation analysis.

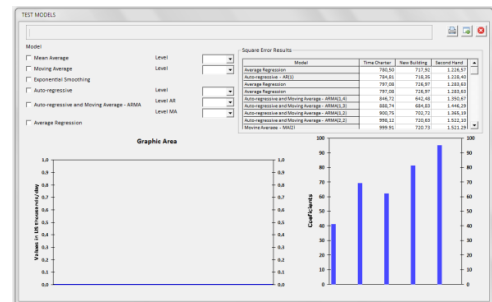


Figure 4 – Time Series Model Selection

3.4 TIME SERIES MODELS SELECTION

In simulation setup, the user must initially select the kind of options to be considered. The system supports options of abandon, defer or lay-up.

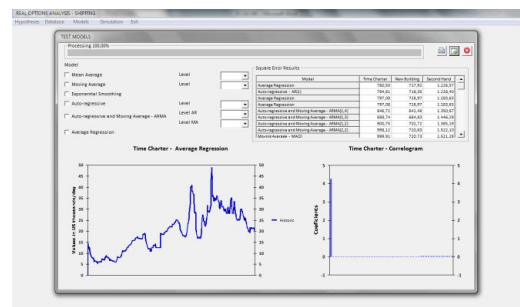


Figure 5 – Time Series Model Indicators

The methodology basically consists in simulating a sample of random paths for the time series, based on the selected models and correlation pattern, then calculating the NPV for each path (or observation). The real options selected are considered in this simulation analysis.

For example, in the case of option to abandon, the decision of continue or not will be simulated at given periods, for each random path. Thus, at these given periods, new samples of random paths are generated. Figure 6 illustrate this sample structure.

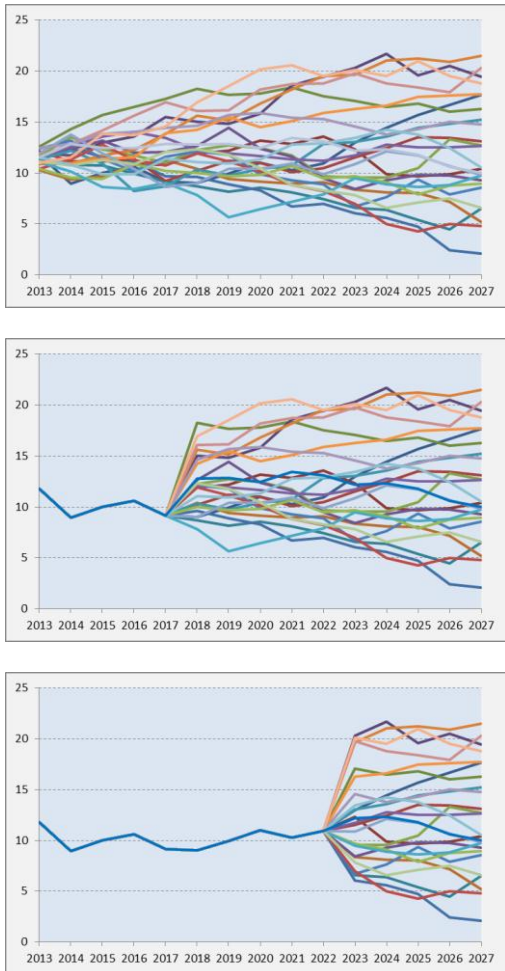


Figure 6 – Simulation of the decision to abandon in years 5 and 10 – sample structure

The simulation setup includes the specification of sample size (sample size or convergence tolerance), the periods to abandonment or lay-up decision, and the limit NPV (NPV_{base}) to continue, abandon, interrupt or retake the project. This limit NPV depends on the risk attitude of the decision maker.

Figure 7 shows the general simulation flow. Figures 8 and 9 illustrate the simulation flows corresponding to the abandon decisions in the 5th and 10th years, and a useful life of 15 years

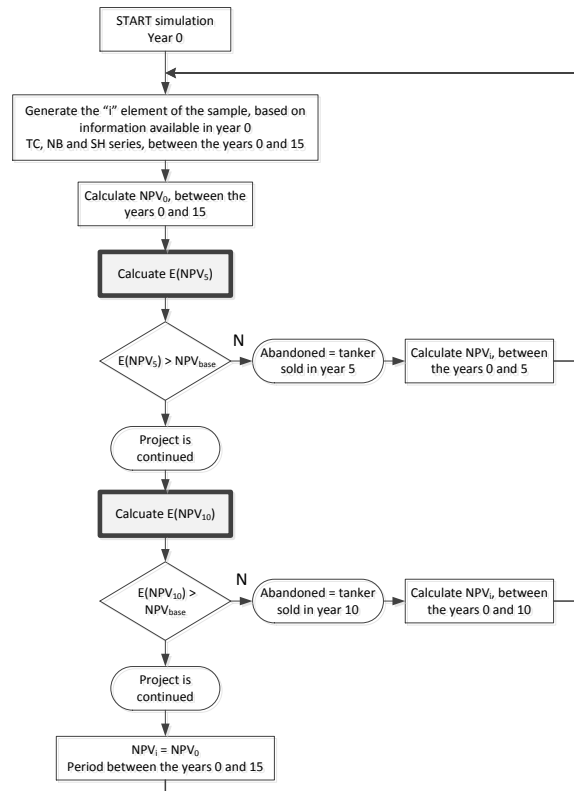


Figure 7 – ROA: simulation with option to abandon in years 5 and 10

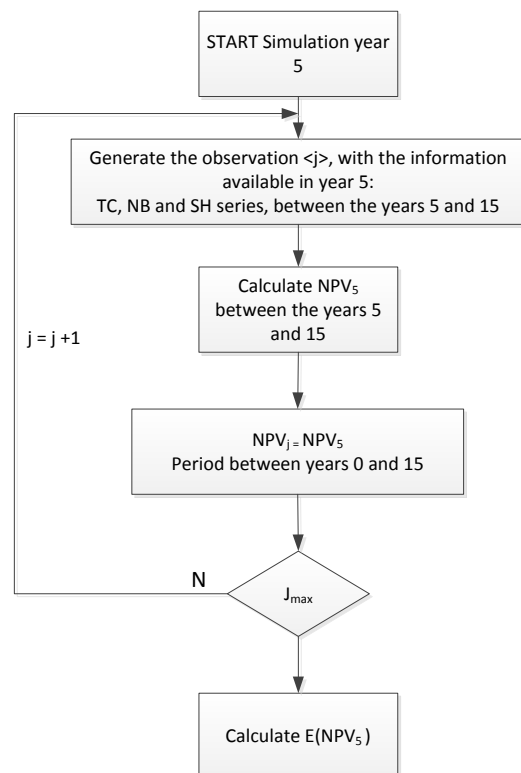


Figure 8 – Simulation of abandon analysis in year 5

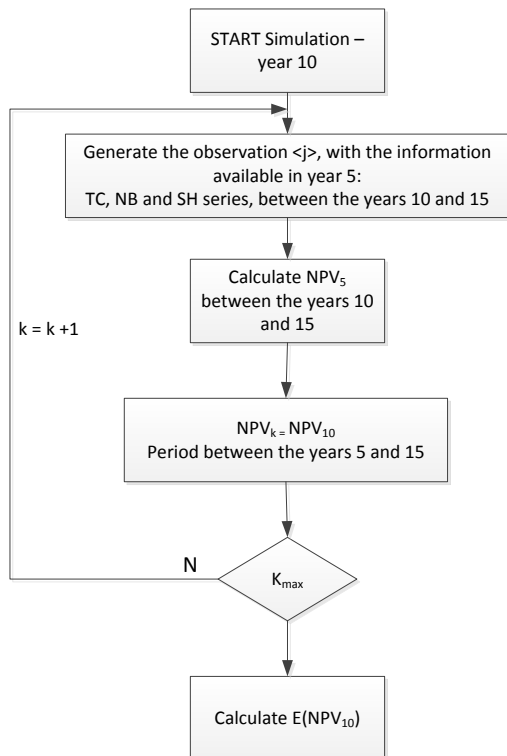


Figure 9 – Simulation of abandon analysis in year 10

3.5. RESULT REPORT

This module generates the reports, as specified by the user. Typical results are the distribution of probabilities of NPV, both without and with the real options, statistics like $E(NPV)$ and 1%, 5% and 10% percentiles, and the curve of option value as a function of NPV_{base} . This curve (Figure 11), indicates the impact of the decision maker's risk attitude on option value and on the project value.

Figures 10 and 11 show examples of typical outputs.

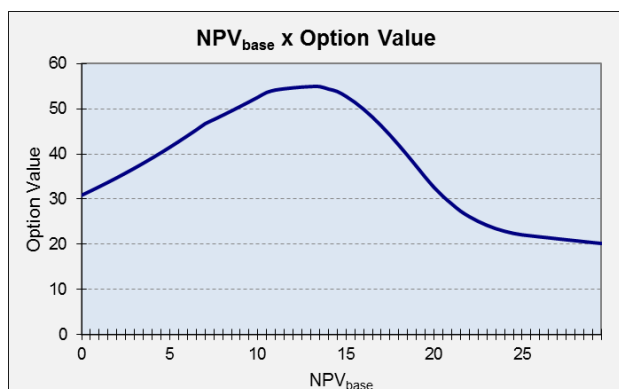


Figure 11 – Value of abandon option in year 5 and 10

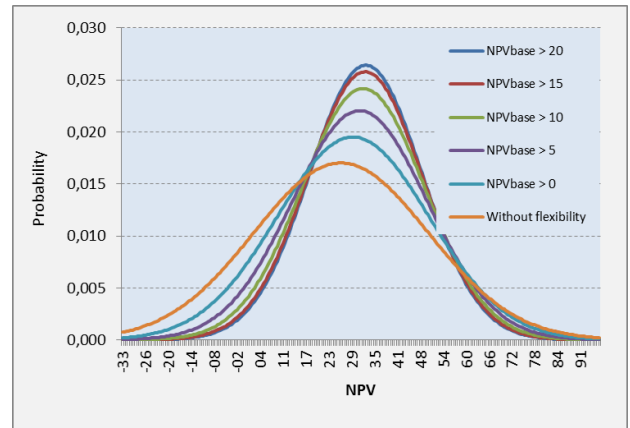


Figure 10 – Distribution of NPV, considering the abandonment option in years 5 and 10

4. CONCLUDING REMARKS

To make easy the application of ROA in ship investment assessment may be a relevant contribution to improve the current practices.

The system presented in this paper allows ROA being applied in the ordinary technical environment of maritime operators. The system can also easily be integrated with information systems typically available in shipping companies and shipyards.

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6. AUTHORS' BIOGRAPHIES

Florianio C M Pires Jr., Naval Architect, M.Sc., D.Sc. He is a Professor at Rio de Janeiro Federal University, Ocean Engineering Department of Graduate School of Engineering – COPPE/UFRJ. He is the Coordinator of the UFRJ Shipbuilding Project Management Laboratory. He is the President of The Brazilian Society of Naval Architects.

M. Rezende Filho, Mechanical Engineer, M.Sc. He is a D.Sc. student at Rio de Janeiro Federal University, Ocean Engineering Department of Graduate School of Engineering – COPPE/UFRJ. He is an Associate Researcher of the UFRJ Shipbuilding Project Management Laboratory.