Concession Agreements in the Shipping Industry

Authors[1]

Juan, C., Olmos, F. Casasus, T. Pérez, J.C.,

Instituto de Economía Internacional
Edificio Departamental Oriental
Campus de Tarongers
Avda. de los Naranjos s/n
46021 Valencia (Spain)

García, L., Feo, M., Monfort, A., Pérez, E., Torregrosa, A

Valenciaport Foundation
Puerto de Valencia
Valencia (Spain)

Abstract

In this paper we present a methodology for designing concession agreements in the shipping industry. Such methodology allows us to make return-risk stochastic analysis of both parts of the concession agreement, to quantify the value of the risk transfers that underlie concessions, and finally to value those sweeteners included in agreements that require a real options approach. We make use of standard stochastic return-risk analysis, joint with a specifically designed numerical algorithm for the sweeteners valuation. The implementation of the whole methodology has been done in Excel and is based on a broad empirical study of the expansion of Valencia Port.

1.1 Introduction

This paper synthesizes the work developed during the last year by a team of researchers who are members of the Institute of International Economics of the University of Valencia, joint with the Port Authorities of Valencia Port. The aim of the cooperation was the valuation of a major expansion project for the port of Valencia. This will consist not only on the traditional revenues-costs analysis, but it should also include a comprehensive risk analysis and take into account the particularities of shipping industry concession agreements.

The result is a multidiscipline work involving, among others, data time series analysis and field research for yielding the growth rates forecasts, analysis of the concession agreements and charges legal frame for identifying the inputs of the revenues-costs model and properly designing the valuation tool, and software design

[1] Corresponding author: Carmen Juan Martínez. E-mail address: m.carmen.juan@uv.es

and programming tasks in order to develop a simulation – valuation engine that could be easily used by managers responsible for taking decisions.

As it usually happens when facing a real valuation project with all its complexity, many interesting problems arise. In our case, the design of concession agreements has turned to be an opened field for developing new real options methodologies. This paper is a quantitative approach to concession valuation that opens a new line of work intended to spread the use of real options among authorities, as a way of improving the quality of concession agreements for both, the citizen whose interests the government protects, and the private industry. So concessions could be seen by society as a precise and well-balanced economic agreement on the basis of a fair two-player game.

The paper is organized as follows: in section 1.2 we describe the global port market. We build the cash flows diagrams of the two agents involved in a concession agreement, the Terminal Operator and the Port Authorities. This way we have all the qualitative information we need for programming our quantitative model of valuation. In section 1.3 we design and implement the traffic forecast model that underlies the valuation model. As there are two parts with different interests in the concession agreement negotiation, we will build two revenues-costs models, one for each one of them, in section 1.4. In section 1.5 we describe how to use our valuation tool in order to find out the exact terms of the final concession agreement which could satisfy the Terminal Operator as well as the Port Authorities. Finally, section 1.6 focuses on the valuation of a sweetener that requires a real options approach.

1.2 Global Container Port Market Description

The general cargo market has been characterized in the last decade by a continuous growth of all general cargo shipments carried in containers. According to the report *Global Container Terminals – Profit, Performance and Prospects by* Drewry Shipping Consultants, "estimated container cargo has grown by an average 8.5% per annum compared with only 3.5% per annum for the total general cargo market overall. As a result, the container share of the total general cargo market has increased from almost 22% in 1980 to an estimated 59% by 2001 and the expectation is that this trend will continue and the figure will be around 75% by 2010".

Let us point out that transhipment has played an important role in these figures, conditioning the development, organization and structure of the shipping industry. In those ports specialized in transhipment we can see figures like the ones of Algeciras (Spain), where 98% of the containers handled at port facilities never pass through port customs. For such specialized port, the natural hinterland's role is no more important than in mixed gateway – transhipment ports. Properly forecasting transhipment traffic flows and how the forecast model will be affected by the operator that finally rules the terminal will be of great importance in finding profitable agreements for concessions, as we will see later in this paper.

If container shipping is becoming an even more important force in world trade, as figures show, then this fact results in the necessity for increasing capacity, especially concerning those terminals specialized in handling containers. Moreover, becoming a hub constitutes a guarantee of throughput, investments and expansion projects. The struggle for such a position, particularly in the Mediterranean, under pressure due to revenues and cost and the increased difficulty in finding sites for expansion, turns the design of expansion projects as well as the concession agreements, into a precise exercise of forecasts and biddings that hopefully results in a null sum game.

At this point, we have to focus on how the shipping industry is organized from the point of view of operating a given terminal that is located at an already operating port. The three agents involved are the Shipping Lines, the Terminal Operator (TO) and the Port Authority (PA). Shipping Lines, once they have decided to call at a particular area, will choose from ports in the neighborhood, and even between terminals inside the same port, depending on the terminal performance (quality of equipment, reliability, vessel connections, handling charges…). On the other hand, TO will decide to invest at a given port depending on his expectations of revenues in that area. Finally, PA will look after the interests of the government. It is usually a government – run entity and has the capacity to negotiate and grant concessions (under the supervision and final approval of the central government).

Most modern container terminals are run under a concession agreement model. A concession is an agreement between the PA and a TO in order to operate certain facilities within a port (for example a terminal) during a given period of time. Concession agreements all over the world share basic general features. Drewry Shipping Consultants illustrate these features in the following diagram.

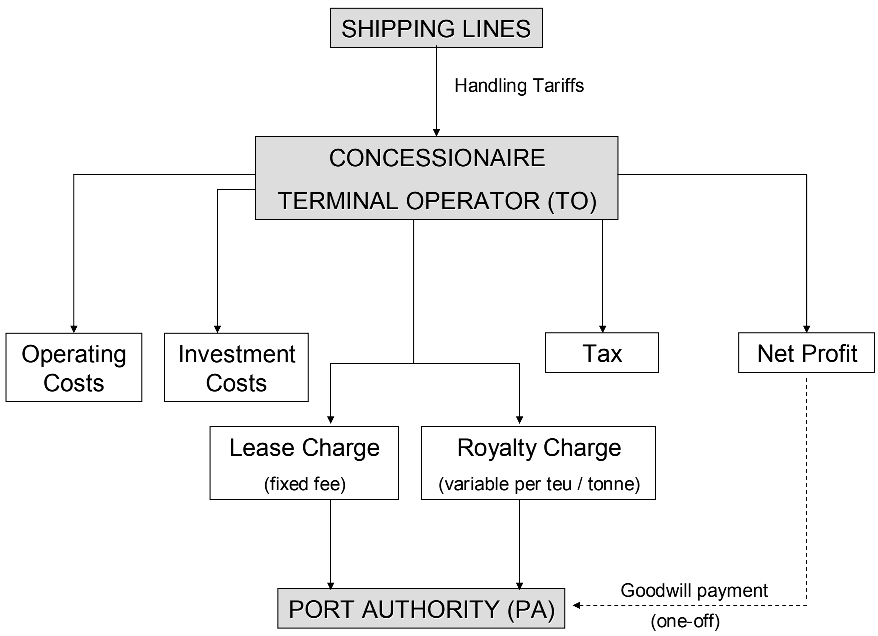


Diagram 1

As we can see, shipping lines pay the TO certain handling tariffs. In some countries those tariffs are capped by the PA. The TO must afford with those incomes his operating costs, investment costs (in some concession models the TO must actually invest in infrastructure, as is the case in this project), taxes and charges. The lease charge and the royalty charge are the key points in a concession agreement. In a negotiation between the PA and the selected bidder in order to reach a Memorandum of Understanding (MOU), most of the time will surely be spent in fixing those charges. The main difference between them is that the lease charge is a fixed fee while the royalty charge depends on traffic throughput and is usually stated in terms of monetary unit per *teu*[2]. From the point of view of risk analysis, this difference requires precise treatment as we will see later on in this paper. Finally, the goodwill payment is a one-off payment the TO makes in order to improve its position in the final bid for the concession. It is usually expressed in terms of a percentage of the expected net profit for one year.

Now that we have understood how a concession scheme works, we will describe in detail our case of study. Our location is the already operating port of Valencia on Spain's Mediterranean cost. Valencia port is striving for becoming a hub in the Mediterranean and is currently developing a major expansion project. For the sake of confidentiality, figures have been slightly modified but the general structure of the expansion project has been kept unchanged. We will work with a basic design of a new terminal with capacity for 2,650,000 *teus* and an investment of 625 million euros. Our aim is to implement a tool that will allow us to determine the following items:

- The project's viability. Before stating the particular terms of a concession, we have to answer the question of whether a terminal operator would be interested in entering the business.
- The lease and royalty charges suitable for starting a negotiation.
- The connection between risks and returns associated to our project. That is, how to improve a bid for a concession taking into account the risk involved in the traffic performance model that underlies the profitability analysis.
- The value of the suitable *sweeteners* to be included in the concession conditions using a Real Options approach.

For properly designing our tool, we will need a more precise model of the cash flows than the general one showed in Diagram 1. First we will have to take into account how charges are implemented by Spanish PA according to Spanish law. This part requires a great deal of patience. As in any country, the system of tariffs, charges and fees concerning shipping and port industry is quite complex. We have tried to summarize it as much as possible in the corresponding diagrams.

[2] *teu* stands for twenty equivalent unit and it is a standard unit of containerization.

Secondly, as we will be taking the point of view of the PA and the TO alternatively, we will have to build a cash flow diagram for each of them. And last, but not least, we need a model to evaluate the project as a whole business, that is, as if it were developed by a single owner (the PA in this case) without a concession agreement. This model will give us a most valuable information: the profitability of the project before splitting it into two parts through a concession agreement. We will begin showing the diagram associated with this last model and its main figures.

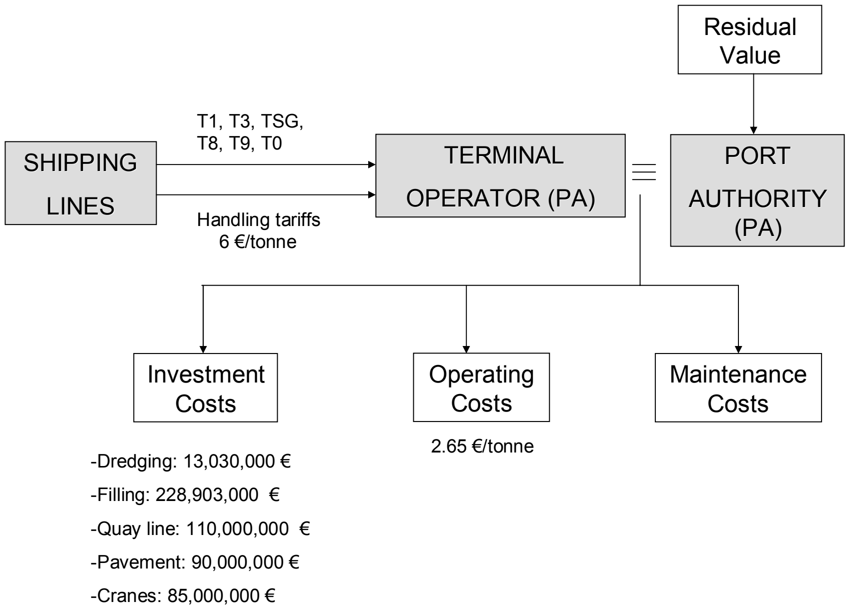


Diagram 2

We have used the common notation in the Spanish port industry T1, T2, T3, TSG, T8, T9 and T0, to refer to the charges under Spanish law concerning ship navigation in the port, berthage and cargo based charges. The next two diagrams show how this business is split into two. Diagram 3 corresponds to the PA business, and Diagram 4 corresponds to the TO business.

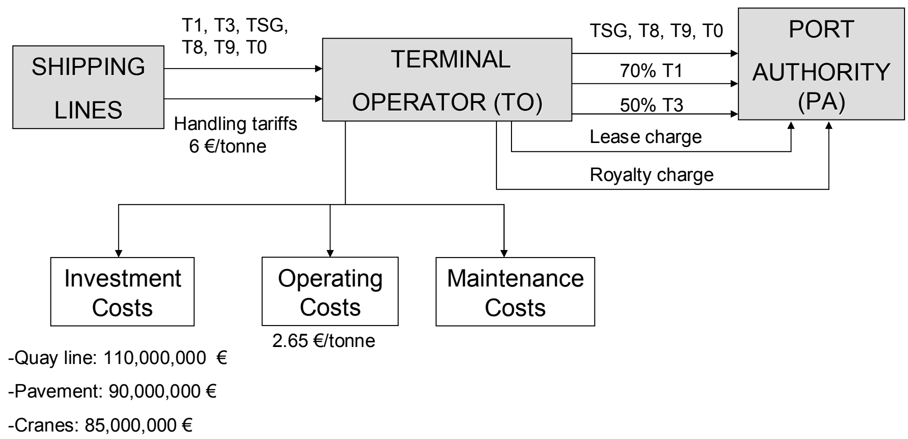


Diagram 3

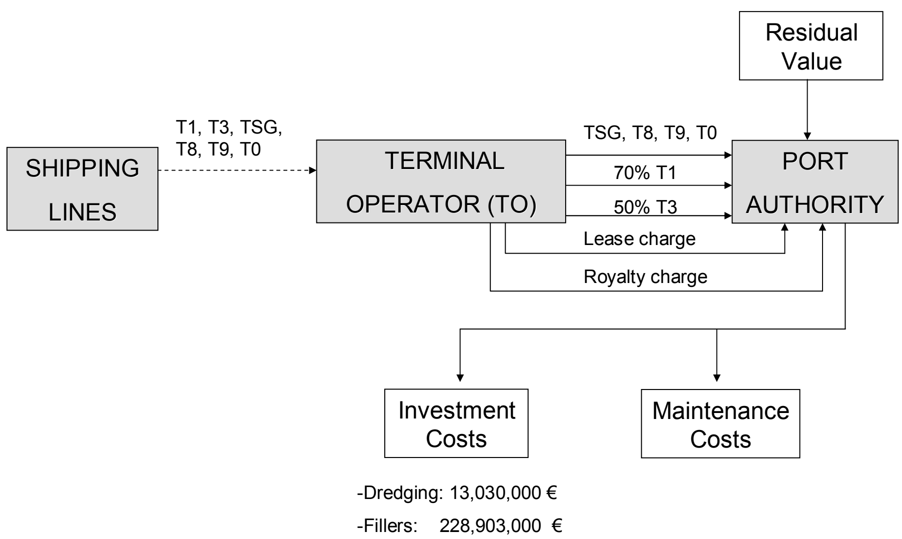


Diagram 4

Let us point out that the investment in breakwaters is not included in the investment costs of the project, because it is usually considered to be financed by the central government. From the two previous diagrams we can conclude that the

PA will be willing to share 30% of the total amount charged to the shipping lines through charge T1, and 50% of the total amount charged through T3, if the TO takes on the investment costs of the quay line and pavement.

Once the rules of the game are settled for both players, we are ready to develop our tool and begin our quantitative analysis of the project and the concession agreement. First we will need a traffic performance forecast model, shared by both parts, which reflects all the uncertainty of the business in the area.

1.3 Traffic Performance Forecast Model

Forecast models used in the shipping industry share some general features:

- Long term forecasts due to the fact that concessions are usually granted for an average of 25 years. Profitability and viability studies based on NPV rules will take the concession period as the period for accumulating cash flows.
- There are official forecast models built by the Government. They take into account international export-import benchmarks and micro and macroeconomic variables. Inside this general frame, each particular port develops its own predictions for traffic performance. This local forecast models try to describe as precisely as possible how a specific port is going to operate in the following years. According to them, Port Authorities will base their capacity expansion requirements.
- They are usually deterministic, analyzing a best case and a worst case scenario.

Our forecast model has the following main features:

- It is programmed using Excel, so it becomes a useful, easy to handle and friendly to the user tool.
- It is designed following the guidelines contained in the manuals edited by the Authorities to this purpose. It may therefore be easily adapted to any Spanish container terminal. Let us note that these Manuals share many features with the international standards for global general cargo market forecasts. In this

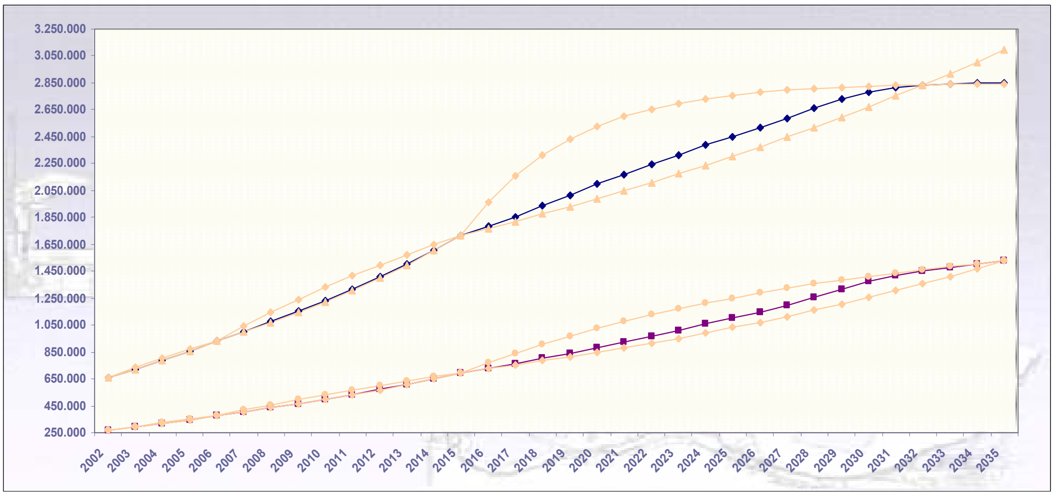
sense, it could also be interesting for operators and Port Authorities in other countries.

- It includes a comprehensive analysis of risk. Risk is estimated before making a proposal for the concession agreement. The risk analysis is made using Crystal Ball® add-in macro for Excel distributed by Decisioneering, Inc.
- It allows us to build single trajectories as part of the simulation process. Trajectories will be used in valuing the sweeteners included in the concession. Such valuations will be based on Real Options methodologies. So we will have to build ad hoc valuation lattices suitable for the type of forecast model we will be dealing with.

To describe how the model works, we will first consider the inputs of the model, and afterwards we will illustrate the outputs and how all the information is handled. The model works with the following inputs:

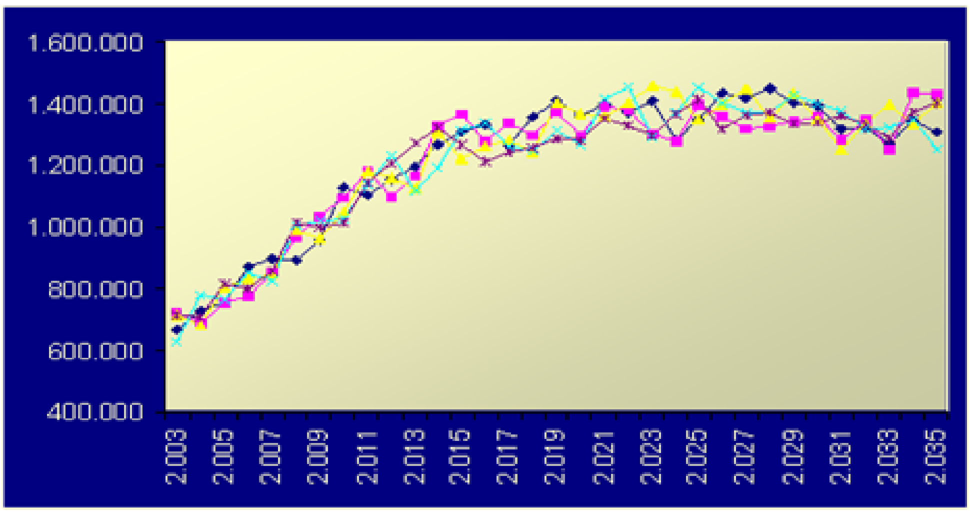
- Goods are organized into 56 types of commodities. So there will be 56 types of containerized commodities. This is the general classification used in Spanish ports.
- Three growth periods (except for transhipment and empties for which we use 5 periods). For each growth period, we use a growth rate which is the result of expectations of that commodity traffic performance.
- Using these growth rates we build a basic trajectory of traffic performance for each commodity. We have handled three types of trajectories: geometric growth, mean reverting growth and an interpolated trajectory in-between the two previous ones.

The following chart illustrates this type of interpolated trajectories for the commodity "Chemestry Export - Import".



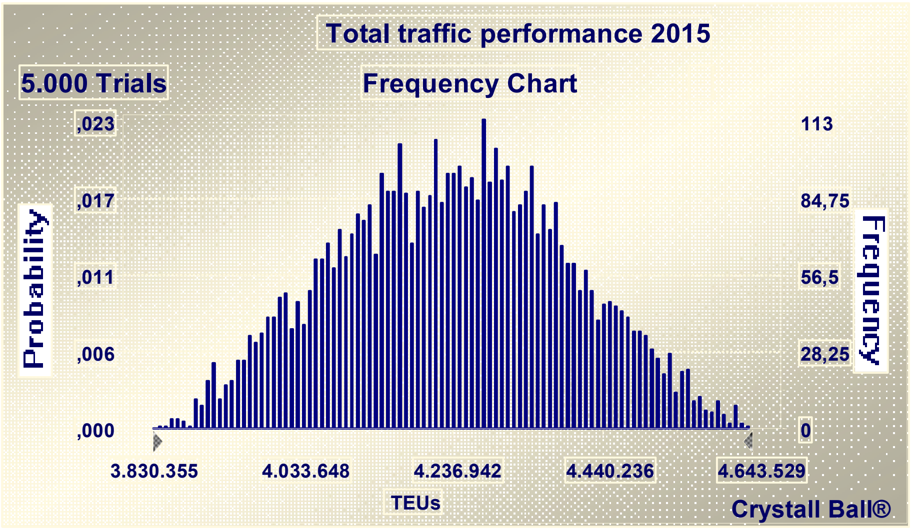
- Uncertainty is introduced in the model using probability distributions. We associate a possible interval of variation and a probability distribution to each one of the growth rates in order to generate simulations. For example, for the commodity "Furniture – import", we have considered that the growth rate for period 2003 – 2006 can take values between 12% and 14% following a normal distribution with expected value of 13%.

Once all the inputs have been introduced, we are ready to run Crystall Ball. A simulation generates the number of trajectories requested. The following chart shows five trajectories of the commodity "Empty containers – import", which has been modeled using a mean – reverting stochastic process.



Outputs of the model:

- Forecast probability distributions. By choosing one or several cells as forecast cells we get comprehensive statistical information about the values such cells take during the simulation. For example, after a 5,000 trials simulation, the total amount of container traffic expected for year 2015 follows the following discrete probability distribution



1.4 Revenues and Costs Forecast Model

As we have explained in section 1.2, a revenues and costs model of a new container terminal which is going to be operated on the basis of a concession, needs a double point of view: the one of the Port Authority and the one of the Terminal Operator who is going to bid for the concession. So we will build a spreadsheet for each one of them.

The PA spreadsheet models the cash flows corresponding to Diagram 4 showed in section 1.2. It uses the traffic growth model described in section 1.3. The uncertainty of this traffic forecast model is inherited by the revenues–costs model. So, as well as for traffic, after a simulation we will obtain the discrete probability distribution of the values of the NPV of the PA project. This way we have not only an expected value for the profitability of the PA part of the business, but also a measure of how risky that business is.

The Terminal Operator spreadsheet models the cash flows corresponding to Diagram 3 showed in section 1.2. It shares the same features as the Port Authority spreadsheet and it gives its counterpart.

Together with these two models, a third revenues–costs model is needed. This model shows the point of view of the project as a whole and is illustrated by Diagram 2 in section 1.2. We build its corresponding spreadsheet, which we will call Whole Project spreadsheet. It will also be based on the traffic forecast model and will give us the figures for estimating net cash flows, and therefore the profitability, of the project.

1.5 Estimating the Royalty Charge

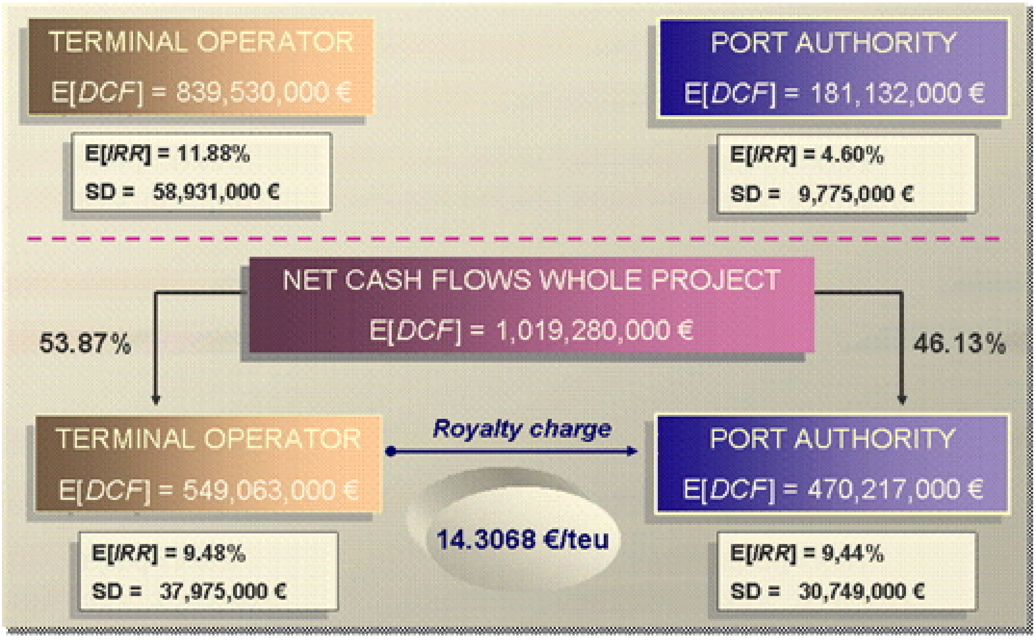
To properly estimate the royalty charge in a concession, we will follow three steps:

Step 1: We estimate a royalty charge so that the PA and the TO share the net cash flows of the whole project in the same proportion they are sharing investment. Moreover, we suppose that there is no lease charge, so both, the Port Authority and the Terminal Operator, share all the risks of the traffic forecast model.

Methodology:

- We use the Whole Project spreadsheet to determine the percentage of investment for each part and, therefore, the amount of net cash flows each investor owns.
- Using OptQuest®, we find a royalty charge so that the PA and the TO expected discounted cash flows share the net cash flows of the whole project in the same proportion they are sharing investment.
- We use simulation to obtain the standard deviation for each one of the two parts and their expected IER.

The following diagram shows the numerical results associated with this first step.



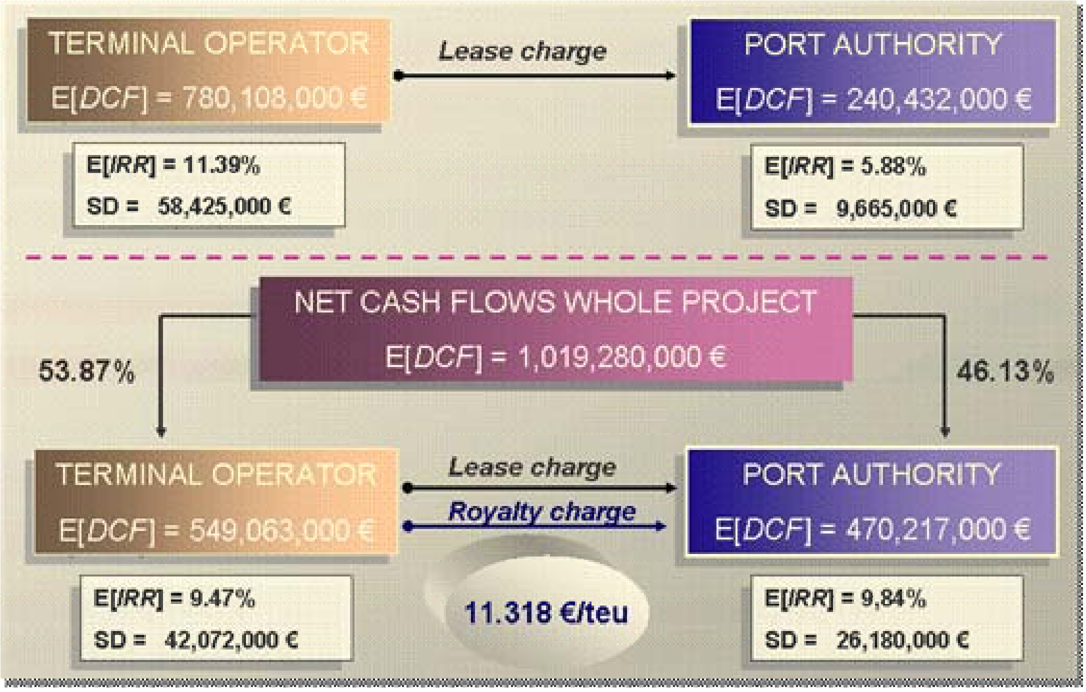
Step 2: The royalty charge found in step 1, models a situation of equality in front of investment and risk. However, all concession agreements use a lease charge joint with a Royalty charge. As we have explained previously, while the royalty charge depends on traffic performance, the Lease charge is a fixed amount the TO must pay and, so, a risk free income that the corresponding PA is going to get.

Therefore there is a so-called risks transfer for which the PA should compensate the Terminal Operator in order to make the concession appealing for potential bidders. In this second step we will determine the new royalty charge that should be paid jointly with the corresponding lease charge so that the Terminal Operator is compensated for his risk increment.

Methodology:

- We introduce the lease charge and we obtain the new figures for both business, the PA and the TO.
- We use OptQuest® in order to find the new royalty charge so that the expected discounted cash flows of TO and PA become the ones stated previously.
- The expected values for cash flows capture the changes in the probability distributions due to the fix amount of lease charge.

The following diagram summarizes the numerical results.



Step 3: Sometimes a Licence can be dedicated to a shipping line, which will become the TO. In these cases there is an additional underlying risk transfer. As a shipping line controls the traffic performance of its own vessels, the uncertainty concerning transhipment decreases. The traffic forecast model must be modified to take into account this fact. Both parts decrease their risks and increase their expected net cash flows values, and the PA may be willing to grant the shipping line in a certain amount. The way the uncertainty is included in our forecast model, allows us to model easily these type of situations and quantify the premiums.

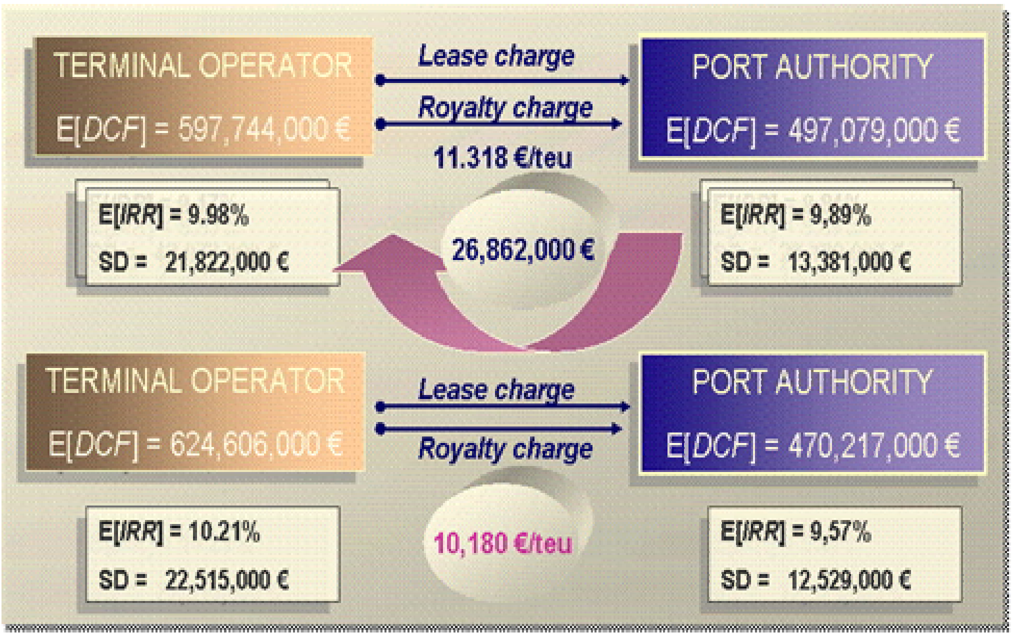
Methodology:

- We identify those traffics for which the fact that a shipping line operates the terminal implies a decrement in uncertainty, as is the case of transhipment.
- We reduce the intervals associated to growth rates, keeping only the part over the proposed growth rate.

	2003-2015	2016-2020	2021-2025	2026-2030	2031-2035
Estimated rate	7.99%	4.5%	3.5%	2.5%	2%
Original range	5% - 10%	3% - 5.5%	2% - 4.5%	1% - 3%	1% - 2.5%
Modified range	7.99% - 10%	4.5% - 5.5%	3.5% - 4.5%	2.5% - 3%	2% - 2-5%

- We obtain then the probability distributions for the net cash flows of the PA and the TO. Again, the PA will be willing to premium the shipping line in the amount corresponding to his increment in expected value.
- We find the new royalty charge reflecting that situation using the same methodology as in the previous steps.

The following diagram shows numerical results for this third step.



1.6 Numerical implementation of a valuation algorithm of "sweeteners" in concession agreements

As we have seen in section 1.5, the design of a concession agreement is a precise exercise of equilibrium between two parts. Our aim was to show that concessions, if they are well designed, can be a profitable joint venture for both, governments and private agents. In this section we would like to go a little further. Often concession agreements are closed forms including only the items we have analyzed in the previous section. We consider that such close forms sometimes fail in their purpose of involving private investors.

A way of solving such problem could be the use of sweeteners in the conditions of the concessions. But they are hardly written in the final concession document. Maybe the lack of such optionality in concession agreements is due to the absence of a spread over and easy to handle methodology for valuing options of this nature. In this section we will illustrate the valuation of what we have called a “compensation option”. This is an exercise we have develop for the PA of Valencia, as a first step in our purpose of introducing real options valuations methodologies in the legal frame of concessions.

The main general features of our valuation tool are the following:

- It is programmed using Excel, interrelated with the traffic forecast model and the returns-costs model we have already seen.
- It uses a valuation methodology based on lattices which has been developed in [3]. A mathematical approach can be found in Appendix A. This summarizes the results presented in [3]. The fact that we will be dealing with only one underlying asset, allows us to use a simplified version of the full algorithm and to implement it in Excel.
- It can be generalized to other type of options as far as they need only one underlying asset for building the valuation lattice.

Let us state our “compensation option” in order to better understand the final design of the valuation algorithm and why it differs from other real options approaches. The compensation option gives the TO the right to be compensated by the PA at given dates during the first 10 years of the concession period. The TO can exercise the option if his discounted and accumulated net cash flows at such dates are under a fixed level. The TO will receive a one-off payment from the PA for the difference. Therefore it is an American style option.

As usually in this type of real options valuations, the TO wants to know how much he will be paying for such a sweetener in his concession agreement. On the contrary, the PA wants to know how much they should expect from his counterpart as good-will payment. At first glance it seems a typical real options problem, but it has two features that turns it into a problem which needs specific valuation methodology:

- The traffic forecast is a continuously increasing forecast model as it happens with most of the models of container traffic performance over the world (the figures in section 1.2 just give a slight idea). Therefore the variable representing the total amount of traffic cannot be modelled using a geometric Brownian stochastic process. Such processes can accumulate continuous decreasing periods which will lead the levels of traffic even out of the worst case scenario of the forecasts appropriate for this particular area of the shipping industry. As the revenues-costs model inherits this feature, using the NPV as stochastic process and underlying asset as we often find in literature, would lead to the same mistake.
- For valuing this option, we must have a register of the "history" of each node of the lattice. For calculating the payoff function, we have to accumulate the cash flows over the past years. Depending on the trajectory that has led us to the node, the result will be different.

For solving these difficulties we propose:

- To use as underlying asset the total amount traffic. To use simulation in order to generate enough trajectories to guarantee reliability in results. To store all the information about those trajectories as well as their discounted cash flows associated.
- To build a numerical lattice following [3], this preserves the behaviour of the original variable. In our case the lattice would look like a cone looking upwards.

Diagram 5 summarizes the steps followed for implementing the valuation tool.

We implemented the following numerical example for the PA of Valencia. Diagram 6 shows the figures of the compensation option as well as its final value. The valuation has been done considering the revenue-costs model of the TO of the concession under study.

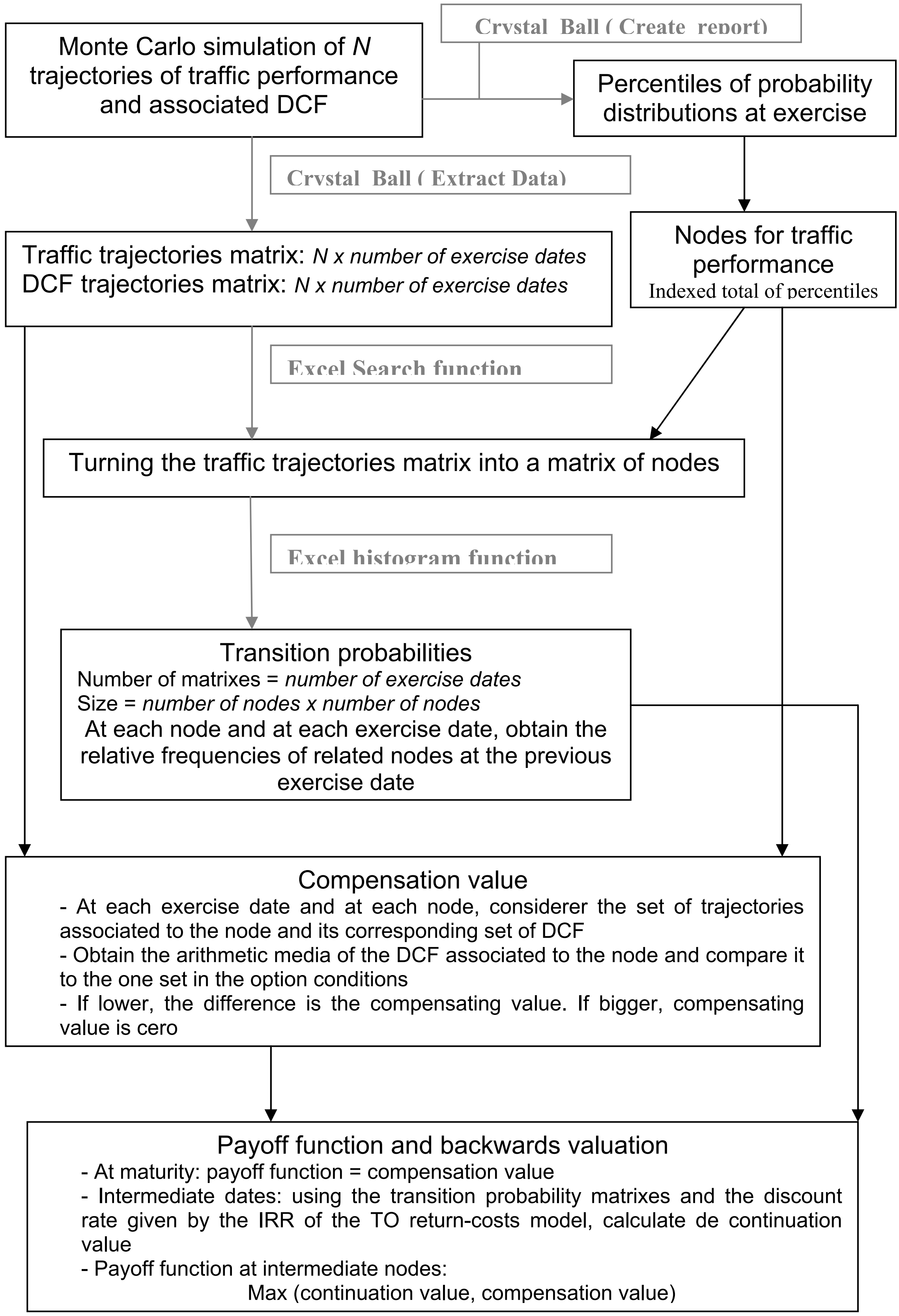

Crystal Ball (Create report)
Monte Carlo simulation of N trajectories of traffic performance and associated DCF
Percentiles of probability distributions at exercise
Crystal Ball (Extract Data)
Nodes for traffic performance
Indexed total of percentiles
Traffic trajectories matrix: N x number of exercise dates
DCF trajectories matrix: N x number of exercise dates
Excel Search function
Turning the traffic trajectories matrix into a matrix of nodes
Excel histogram function
Transition probabilities
Number of matrixes = number of exercise dates
Size = number of nodes x number of nodes
At each node and at each exercise date, obtain the relative frequencies of related nodes at the previous exercise date
Compensation value
- At each exercise date and at each node, considerer the set of trajectories associated to the node and its corresponding set of DCF
- Obtain the arithmetic media of the DCF associated to the node and compare it to the one set in the option conditions
- If lower, the difference is the compensating value. If bigger, compensating value is cero
Payoff function and backwards valuation
- At maturity: payoff function = compensation value
- Intermediate dates: using the transition probability matrixes and the discount rate given by the IRR of the TO return-costs model, calculate de continuation value
- Payoff function at intermediate nodes:
Max (continuation value, compensation value)

Diagram 5

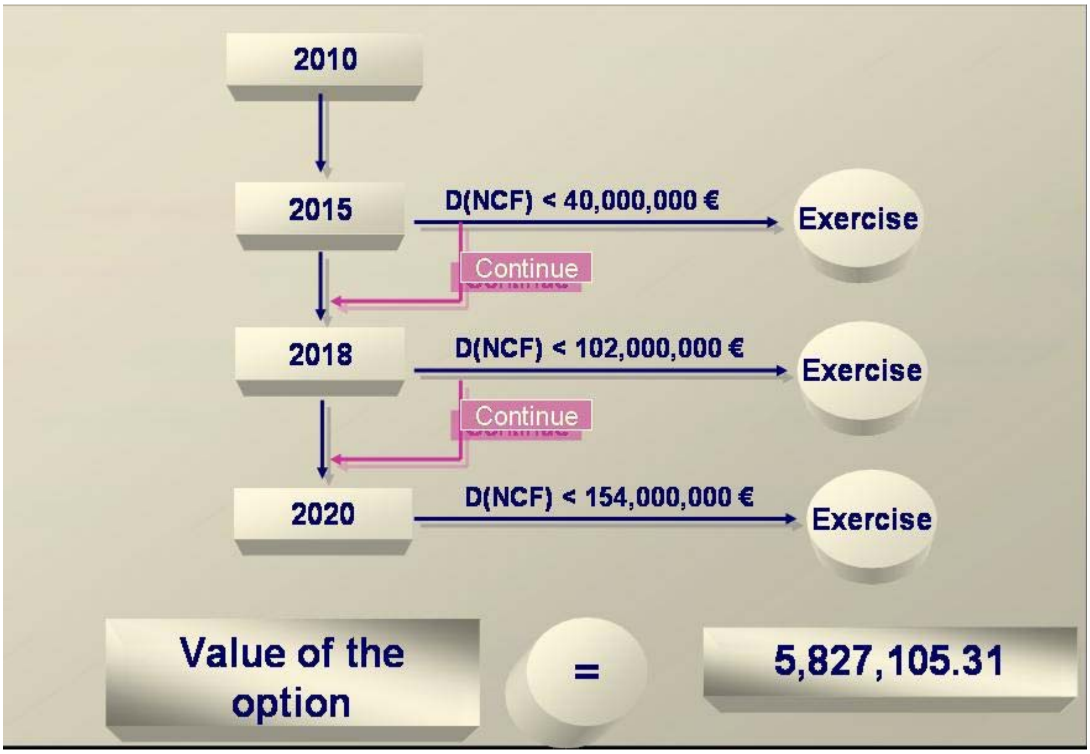

2010
2015
D(NCF) < 40,000,000 €
Exercise
Continue
2018
D(NCF) < 102,000,000 €
Exercise
Continue
2020
D(NCF) < 154,000,000 €
Exercise
Value of the option
=
5,827,105.31

Diagram 6

Appendix A: Scenarios-Monte Carlo Algorithm.

The algorithm has three stages: generation of scenarios spaces, relation between consecutive scenarios spaces and valuation process. Scenarios spaces describe quantitatively situations the project manager would face, each one with its corresponding probability. Each scenario plays a role similar to a node of a valuation lattice and allows us to calculate the payoff function according to optionality. A relation between consecutive scenarios spaces allows us to calculate expected continuation values. Finally, the valuation process, as usual in valuation lattices, works backwards. Let us describe each stage in detail.

Stage 1: Generation of Scenarios Spaces.

Uncorrelated dynamics. For generating the scenarios spaces, let us consider m state variables denoted by N_i, $i = 1 \ldots m$. The dynamic of each variable is given by a stochastic process. We suppose that such dynamics are independent. The parameters used can be adjusted either to accomplish risk-neutral valuation or to model managers' expectations.

At a given time τ, we get B samples of each state variable N_i, using Monte Carlo simulation. We build the histogram associated to these B samples, which gives us a probability distribution of the state variable N_i at time τ. So we are considering m different histograms, one for each variable.

From them, we build m-dimensional arrays by making the Cartesian product of the m sets of representative values of the classes of each histogram. Each array denoted by e_τ will be called a scenario.

The probability of e_τ is the product of the probabilities of its components. All scenarios e_τ build a scenarios space ξ_τ at time τ. Their probabilities build a complete probability distribution Q_τ on e_τ.

Correlated dynamics. Let us summarized the steps for generating scenarios spaces when variables are correlated:

1-We generate correlated state variables arrays using Cholesky factorization method.

2- We build a finite disjoint partition of the space of outcomes in multi-dimensional cubes and choose a representative array for each cube.

3- Using the maximum norm, we locate each outcome in a multidimensional cube.

4- We build the multidimensional histogram of frequencies and assign probabilities.

Stage 2: Relation between consecutive scenarios spaces. Transition probabilities.

Let us consider at date τ a scenario e_τ belonging to the scenarios space ξ_τ. Considering e_τ as initial value and the dynamics of the *m* state variables, we use Monte Carlo simulation to get *B* samples S_i at τ+1 of *m*-dimensional arrays associated with e_τ. For each S_i, we find the scenario $e_{\tau+1}(i)$ belonging to $e_{\tau+1}(i)$ which is closest to S_i using the Euclidean norm. We consider then that $e_{\tau+1}(i)$ is related to e_τ.

So e_τ is related *B* times with scenarios at τ +1. The transition probability from e_τ to one of these (τ+1)-scenarios is given by the frequency the (τ+1)-scenario appears. The expected continuation value CV at e_τ will be then calculated as usual during the valuation process.

Stage 3: Valuation algorithm steps.

Let us consider a valuation problem involving *m* state variables and *n+1* possible exercise dates τ, $\tau = 0, \ldots ,n$ ($\tau = 0$ represents the actual date). We will denote by *Pf* the payoff function. The steps of the algorithm are as follows:

Step 1: Generation of the scenarios space at maturity $\tau = n$.

At each scenario e_n, we calculate $Pf(e_n)$ considering the optionality involved.

Step τ: Generation of the scenarios space at date $0 < \tau < n$

At each scenario e_τ, we calculate the expected continuation value $CV(e\ )$.

At each scenario e_τ, we calculate $Pf(e_\tau)$ as maximum among $CV(e_\tau)$ and the expected cash flows considering the optionality involved.

Final Step. At the unique scenario e_0 at τ=0, we calculate the expected continuation value $CV(e_0)$.

The final value of the valuation is given by $Pf(e_0)$ as maximum among $CV(e_0)$ and the expected cash flows considering the optionality involved.

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