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The Purpose of Project Economic Models

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Abstract

Models come in different forms: visual, arithmetic, mental, physical. The most common type of model is arguably the mental model, which people use to view and interpret the world. A model can be described as a representation of a problem or a situation – a simplified representation. The process of building or developing a model is called *modeling.* A model once developed by the modeller, can be 'owned' by a manager or decision maker. The ideal is to make the model an extension of the user's ability to think about and analyse problems or situations. When used properly – taking into consideration its limitations – an economic model for a project can provide insight for decision makers, when making the crucial decision to approve a project. An economic model for a liquefied natural gas (LNG) project is shown as an example.

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1 Why Model?

When asked the question "why model?" Epstein (2008) answered:

You *are* a modeler. Anyone who ventures a projection, or imagines...is running *some* model...But typically, it is an *implicit* model in which the assumptions are hidden, their

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internal consistency is untested, their logical consequences are unknown, and their relation to data is unknown. But, when you close your eyes and imagine an epidemic spreading, or any other social dynamic, you are running *some* model or other. It is just an implicit model that you haven't written down…The choice, then, is not whether to build models; it's whether to build *explicit* ones. In *explicit* models, assumptions are laid out in detail, so we can study exactly what they entail. On these assumptions, *this* sort of thing happens. When you alter the assumptions *that* is what happens. By writing explicit models, you let others replicate your results…Another advantage of explicit models is the feasibility of sensitivity analysis. One can sweep a huge range of parameters over a vast range of possible scenarios to identify the most salient uncertainties, regions of robustness, and important thresholds. I don't see how to do that with an implicit mental model. It is important to note that in the policy sphere (if not in particle physics) models do *not* obviate the need for judgment. However, by revealing tradeoffs, uncertainties, and sensitivities, models can *discipline the dialogue* about options and make unavoidable judgments more considered.

Generally speaking, models come in different forms: visual, arithmetic, mental, physical. The most common type of model is arguably the mental model, which people use to view and interpret the world.

Regarding mental model, Forrester (1995) opined:

Every person in private life and in business instinctively uses models for decision making, the mental images in one's head about one's surroundings are models…One uses selected concepts and relationships to represent real systems. A mental image is a model. All decisions are taken on the basis of models…the question is not to use or ignore models. The question is only a choice among alternative models.

A model can be described as a representation of a problem or a situation – a simplified representation. The process of building or developing a model is called *modeling*: continued refining and analysis of the representation for more insight and better decision making for the user of the model (Powell and Baker, 2011). A model can also be described as an abstraction, a miniature construct removing the complexities of the real world, a laboratory or artificial environment for testing ideas. Quantitative models help analysts, and other model users, to improve their quantitative reasoning skills. Models often help structure problems when trying to solve them.

Models play a central role in the hard, exact sciences. The intention of scientific inquiry, and the result from such inquiry is to shed light (understanding) and mastery (control) of a part of the universe. According

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to Rosenbleuth and Wiener (1945), this understanding and mastery cannot be achieved without abstraction: “No substantial part of the universe is so simple that it can be grasped and controlled without abstraction.” The part of the universe under consideration, is replaced by a model of similar but simpler structure, through abstraction.

Arguably the greatest scientist ever, Isaac Newton (1687) created a model to help explain gravity: the Newtonian *model* of gravitational attraction, shows that the force between two objects of mass m_1 and m_2 a distance r apart is given by:

$$F=Gm_1 m_2 /r^2$$

where G is the universal gravitational constant.

Maki (2005) claims that models are experiments and experiments are models:

[Models] serve as a substitute system of the target system they represent…models involve a *semantic* aspect (characterized by the notions of representation and resemblance) and an *epistemic* aspect (characterized by the aim of acquiring information about the target system by examining a representative substitute system).

An important function of models is that they help us refine our intuition. This happens when models clarify the nature of hypotheses, by exposing the logic of these hypotheses, making them clear by showing what the hypotheses depend on and what they do not depend on.

Economic modeling is about intuition made transparent by logic, intuition disciplined by plausible evidence.

Rodrik (2015) argues that for an economic model to be useful (in the sense of tracking reality), the model’s critical assumptions have to “track reality sufficiently closely.” Rodrik, goes further to describe *critical* assumptions of an economic model:

An assumption is critical if its modification in an arguably more realistic direction would produce a substantive difference in the conclusion produced by the model. Many, if not most, assumptions are not critical in this sense…models often make assumptions that are critical but unstated. Failing to scrutinize those assumptions can lead to severe problems in practice…models generate conclusions by pairing assumptions with mechanisms of causation.

Little (1970) suggests that for a model to be useful for a manager or decision maker, it should be:

Simple
Robust
Easy to control
Adaptive
As complete as possible
Easy to communicate with

Such a model once developed by the modeler, can be then 'owned' by a manager or decision maker. The ideal is to make the model an extension of the user's ability to think about and analyse problems or situations.

2 Quality assurance in spreadsheets modeling

The emphasis during model development is to make the model user-friendly for all model *users* and for any further work done by future model *developers*. A spreadsheet model is simply a set of variables with a set of logical and quantitative relationships between the variables, constructed in a spreadsheet. This model should be created to be easy for a user to understand and use, with inputs and outputs expressed in everyday terms with readily interpretable units. Sensitivity analysis should be easy to do with the model.

The Spread Sheets Standards Review Board (SSSRB**)** is the body that develops and maintains the Best Practice Spreadsheets Modelling Standards, such as the Best Practice Spreadsheet Modelling Standard Version 7.1 (2015). SSSRB believes that the adherence to internationally recognized standards is important. Traditionally, model developers developed models according to individual tastes and preferences, because there were no generally-accepted principles governing the model development process. Model developers have had difficulty understanding and utilizing models developed by others, because of this lack of standardization. This has resulted in confusion, frustration and inefficiency.

3 Liquefied Natural Gas (LNG) project example

A deterministic model for economic analysis of a LNG project is presented here. The logic and mathematics that link the elements of the model

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together are described. The model is a discounted cash flow (DCF) model. The net present value (NPV) is the value of the sum of all future project cash flows (outflows and inflows), discounted back to the time of project sanction or final investment decision (FID) date, this is shown mathematically as:

$$NPV = \sum_{t=1}^{n} \frac{NCF}{(1+i_d)^t}$$

Where:

NCF = Net cash flow

i_d = Discount factor

t = Time (years)

The DCF model has three steps as illustrated below:

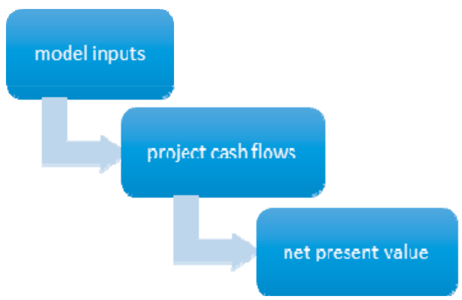

Figure 1: The three steps involved a discounted cash flow (DCF) analysis

The internal rate of return (IRR) of the project is calculated as the discount rate that makes the net present value (NPV) = 0.

This model's critical assumptions are those inputs into the model, whose modifications (to make them more realistic) would result in a substantive difference in the model's conclusions, for example:

a) Capital expenditure (CAPEX)
b) Operating expenditure (OPEX)
c) LNG plant capacity
d) Feed gas price (feed gas quality + quantity)
e) Product sales price (LNG/LPG/Condensates)
f) Oil price (Brent)
g) Plant operational life

h) Taxes
i) Financing
j) NPV discount rate

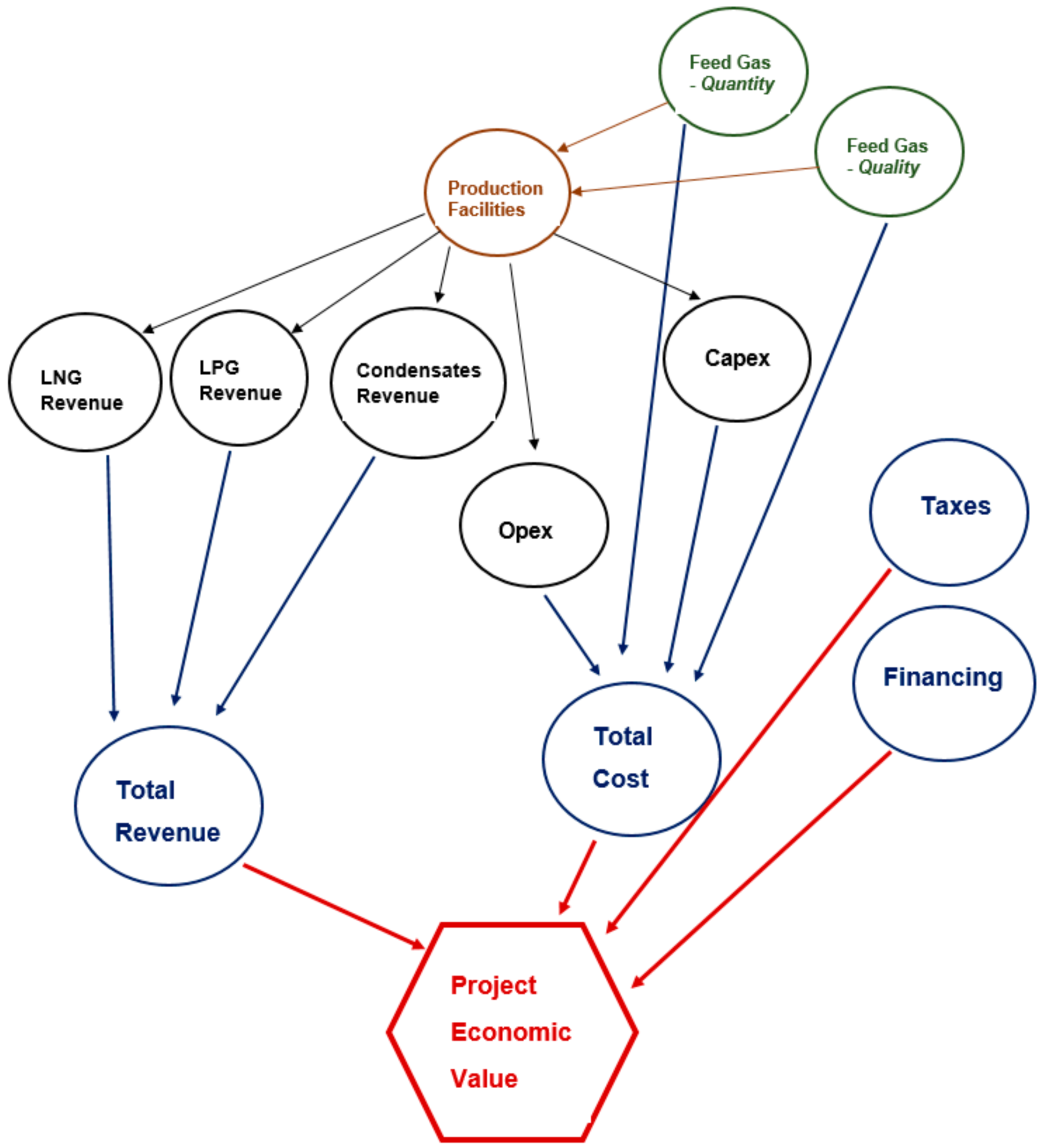

Figure 2: The influence diagram for a LNG project

Specific terminology used during economic analysis with the LNG economic model include:

Input: a numeric value required by the model

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Parameter: any input that is systematically varied through a range of values

Output: a numeric value computed by the model (e.g NPV / IRR)

Data variable: an input, the value of which is decided outside the model (e,g oil price)

Decision variable: an input, the value of which is controlled as a choice in the model (e.g financing)

Scenario: a set of values for all data variables in the model

Plan: a set of values for all decision variables in the model

Case: a set of values for all inputs (data and decision variables) in the model

Sensitivity analysis involves the systematic varying of one or more model inputs (e.g CAPEX / OPEX) and recording the impact on one or more model outputs (e,g NPV / IRR). The results of sensitivity analyses are usually displayed as tornado diagrams or spider charts.

4 Conclusion

When used properly – taking into consideration its limitations – an economic models of a project can provide insight for decision makers. Models imply structure and relationships among variables, useful in problem solving and decision analysis. Models can help to expose, analyse and sharpen intuition. Models can also help to improve quantitative reasoning of the modelers and decision makers. Crucially, economic models can help decide whether a multi-billion-dollar project is approved or not.

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