

Sustainability Option: Application to BP's Deepwater Horizon Case

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She also wrote with Tony Cabot *Quantify Sustainability: a new factor inside insurance pricing*, 2015, published by Argo Group International Holding, Ltd. This paper is also based on evidences and results of her thesis *Sustainability in the insurance industry connected to the credit and surety line of business. Governance and pricing: theoretical aspects and applications* with Professor Piera Mazzoleni as thesis supervisor, 2014 - M.Sc. in Actuarial and Economic Statistical Sciences, Università Cattolica del Sacro Cuore, Milano.

Abstract

Sustainability is a strategy that impacts project value estimation. The aim of this study is to present a model based on a Real Option approach which introduces Sustainability in project evaluation using the “Real Option for Sustainability”. From the purpose of this paper, Sustainability means to invest in mitigating environmental, social and governance (hereinafter ESG) risks. Therefore, we find that under our model, sustainable projects present also an actual value resulting in the mitigation of their ESG risks. This evaluation is useful for helping Management to take decisions and for all the stakeholders because it provides further elements when considering projects’ capability of generating value over time.

This paper is structured as follows: firstly, we present the Sustainability topic and secondly, we propose a Real Option methodology for sustainable strategies’ evaluation and a related illustrative case study based on the British Petroleum's management decisions that caused the Deepwater Horizon disaster (on 20th April 2010).

Keywords – sustainability; triple bottom line; ESG factors; real option; real option for sustainability.

Introduction

Why should an economic initiative (company or project) adopt a behavior based on Sustainability? What does it mean when an economic initiative (company or project) adopts a sustainable behavior?

The Sustainability topic represents a fundamental issue for this century. The aim of this paper is to introduce a real option to consider Sustainability in the evaluation of an economic initiative.

The definition of Sustainability is not univocal. This is the reason why, in the first section, we describe how the “sustainable” concept was developed by international communities according to UN guidelines.

In particular, for a company/project, the aim of a Sustainability strategy is to reduce the risks of failure. We adopt the ESG factors and the Triple Bottom Line concepts and argue about the opportunity to take these factors into account in economic projects, with the result of affecting positively the economic performance of a company/ project.

Furthermore, we show that adopting a Sustainability strategy has several points of strength. For example, investments in safety, the implementation of an early warning system and alerts, are beneficial to mitigating the impact of expected loss, to recovery and to the probability of reducing or eliminating adverse events.

Therefore, there are *ex-ante* benefits for an organization’s defense against such events and *ex-post* benefits arising from pre-qualified intervention plans, which can help contain losses and can save important intangible assets, such as the Company’s image and reputation over time.

The aim of the “Real Option for Sustainability”, introduced in this paper in the second section, is to be a strategic management tool, when it is a risk mitigation instrument linked with ESG factors.

In particular the real option presented is used for evaluating the opportunity to invest in covering the risks correlated with ESG factors, establishing, in this way, a threshold of prevention against a specific adverse event at a given time.

In the third section, we propose an application of the Real Option for Sustainability in the Oil sector. The reason is that sustainable investments are deeply relevant in this sector, hence decisions concerning them should be at the core of the project planning phase. The business study that is analyzed is the disaster occurred on the Deepwater Horizon of British Petroleum in 2010. After a screening of the main dynamics of the event, as costs, losses and

wrongdoings, we calculate the value of the option of a project of drilling an oil well, analyzing the benefits that can derive from using sustainable strategies.

Section 1

KEY CONCEPTS OF SUSTAINABILITY

The world must be able to cope with present and future challenges brought by new drivers of change, such as demography, environment, technology and values in behaviours and contents.

Social sensibility demands companies, and people who work in them, to be compliant with these drivers of change. The Market's specific focus on profit is not enough to reach a competitive advantage based on Sustainability, which increases the recognition of a company's reputation through its ability to operate and do it well.

According to Elkington's example, four main types of companies, or "value webs", are distinguishable along the evolutionary path to a "chrysalis economy"¹.

This concept can be explained with the image of a flowered garden. Four kind of insects live in that garden. There are locusts that destroy the garden by eating and ruining the grass and the flowers everywhere. Moreover there are also caterpillars, called also "eating machines", that eat leaves voraciously only in a single point of the garden. Butterflies also live in the garden, but do not destroy anything and live only one day. Finally, the fourth kind of insects are honeybees. Honeybees not only do not ruin the garden but also create the maintenance, they are strongly regenerative, in other words they are sustainable.

The metaphor is clear, Sustainability is the key to keep going and it is the fundamental issue of this century.

The definition of Sustainability² (or sustainable development) is not univocal and it has developed over time. We chose to adopt the UN definitions for the purposes of this paper³:

¹ The Chrysalis Economy: How Citizen CEOs and Corporations Can Fuse Values and Value Creation, (2001). Elkington, J., *Cannibals with forks: The Triple Bottom Line of 21st Century Business*, Oxford, UK: Capstone, 1998.

² Sustainability is a topic of greater interest in public argumentations. The etymology of the term derives from Latin, the verb to sustain is composed by two words sub - it means up (from below), upward – and *tenere* – it means to keep, to hold. Thus, *sub-tenere* means to hold in high, to hold up, to bring on himself, fig. to wield, to take care, to shield, to retain, to maintain, to feed. It was used also for to resist/ withstand the enemy or adversity. Thus, the idea behind sustainability is the possibility to give continuity to something.

(<http://www.etimo.it>)

³ Our Common Future the Brundtland Commission, 1987, United Nations World Commission on Environment and Development, Part 1, Chapter 2.

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.*

Therefore, environment, society and governance (ESG) identify the three main factors in measuring the sustainability.

In the 1980s, new concepts about interactions between financial performance and “social capital”⁴ started to diffuse⁵. Furthermore, new awareness about environmental issues developed as a result of some disasters, such as oil spills⁶.

The need of responsible investment products was granted by the investment market. According to Elkington, non-financial factors must be included in a company’s performance analysis in order to describe better its real value and business.

Interconnections between environmental aspects and finance have been studied by research teams, including the groups of Chris Yates-Smith⁷. Afterwards, many banks and investment funds in the world started to weigh up ESG factors in their investments.

⁴ Coleman J. S., *Social Capital in the Creation of Human Capital* in the American Journal of Sociology, 1988.

⁵ Milton Friedman’s theory had a great impact on economic views during the second half of 20th century. In his works (Friedman, M. – Friedman, R., Free to choose: a personal statement, London, Secker & Warburg, 1980. Friedman, M., Essays in positive economics, Chicago, University of Chicago Press, 1966), he disputed the point of view according to which social responsibility has a positive impact on financial performances of a company; moreover, he attacked the rule of regulation and interventions of governments, arguing that these deteriorate the macro economy. Thus, his main idea was that companies’ strategies and choices are based only on profits/costs. Nevertheless, many researches appeared during 20th and 21st centuries to support the contrary argument.

⁶ In 1989, 260,000 barrels of crude oil from the Exxon Valdez oil tanker poured on the waters of Alaska's Prince William Sound. That oil spill covered 1,300 miles (2,100 km) of pristine coastline. Thus, the redefinitions of risk were revised from the high financial and environmental cost supported.

⁷ In 2002, he took part in an informal group *The Virtuous Circle*, in London. In 2005, he established a private environmental metrics (researches on environmental accords and ISO standards) Environmetrics, in Lisbon.

Of the three areas concerning ESG, Moskowitz⁸, a journalist, highlighted the importance of good governance for corporates in financial performances. Consequently, he published a list of companies, focusing on corporate management, in particular on the relationship with the shareholders and on workers conditions. In fact, he has argued that better corporate governance practices, if (effectively) implemented with the aim of managing resources and developing talents, without compromising financial performances, can positively affect productivity. This intuition was supported by Edmans' publication⁹ in which he suggested the one hundred best companies to work for in America because they had a superior performance than their competitors – the long-run stock returns were 2-3% greater than the industry benchmarks a year, over 1984-2009. It is shown that these results were consistent with the human relations theory:

Firms with high levels of employee satisfaction generate superior long-horizon returns, even when controlling for industries, factor risk, or a broad set of observable characteristics¹⁰.

Moreover, there is a report, commissioned by the UNEP Financial Initiatives to Freshfields Bruckhaus Deringer¹¹ regarding investors and ESG issues for investment companies; the final results saw the integration of those factors as a fiduciary duty of these companies¹². Furthermore, other studies were conducted on this subject. Barnett and Salomon¹³ analyzed *the curvilinear relationship* between financial and social performance, by studying social screening strategies on a sample of 61 mutual funds that practiced socially responsible investing from 1972-2000. This research shows *that as the number of social screens used by an SRI fund increases, financial returns decline at first, but then rebound as the number of screens reaches a maximum*¹⁴ (as a curvilinear relationship). Consequently, the application of different kinds of social screens brings to different financial performances:

⁸ Moskowitz, M., *Choosing socially responsible stocks*, Business and Society Review, 1: 71-75, 1972. Levering, R. - Moskowitz, M. - Katz, M., *The 100 Best Companies to Work For in America*, Addison - Wesley, Reading, 1984. Levering, R. - Moskowitz, M. *The 100 Best Companies to Work For in America*, Plumbe, New

⁹ Edmans, A., *Does the Stock Market Fully Value Intangibles? Employee Satisfaction and Equity Prices*, Journal of Financial Economics, 101, 2011.

¹⁰ Ibidem.

¹¹ It is an international law firm, see <http://www.freshfields.com/en/global/>.

¹² http://www.unepfi.org/fileadmin/documents/freshfields_legal_resp_20051123.pdf, 2005.

¹³ Barnett, M. - Salomon, R., *Beyond Dichotomy: The Curvilinear Relationship between Social Responsibility and Financial Performance*, Strategic Management Journal, 27, 2006.

¹⁴ Ibidem.

Funds that use few screens gain the benefits of diversification, and those that filter stocks and limit their universe of investments do not handicap their portfolio as much as some contend. The real danger lies in not committing to one strategy or the other- in being ‘stuck in the middle’¹⁵.

Therefore, sustainability is a strategy, and the Triple Bottom Line (3BL or TBL)– People, Profit, Planet - is the framework coined by Elkington that summarizes all the areas regarding the concept of sustainability. It is used to report ESG issues' outcomes and identify corporate impacts.

The underlying idea behind 3BL is that business corporations can create value in many interconnected fields¹⁶: environmental, social and economic areas.

¹⁵ Ibidem.

¹⁶“The better the system of cg the greater the chance that we can build towards genuinely sustainable capitalism”. Elkington, J., *The triple bottom line does it all add up? Assessing the sustainability of business and CSR*, edited by Henriques A. - Richardson, J., Earthscan, 2004. Nevertheless, this theory has been also criticized as follows:

1. The economic dimension is often intended as the only financial performance, instead it must assume a broader meaning (Henriques, A., *The triple bottom line does it all add up? Assessing the sustainability of business and CSR*, edited by Henriques A. - Richardson, J., Earthscan, 2004.).
2. Better accounting must consider a wider concept of capital and the temporality of sustainability (Ibidem).
3. Reductive method: since the triple bottom line is a corporate-oriented approach, the social and environmental dimensions are less significant than the economic that instead represents the focus of interest (Scerri, A. - James, P., *Accounting for sustainability: Combining qualitative and quantitative research in developing ‘indicators’ of sustainability*, International Journal of Social Research Methodology 13, 2010. Therefore, an alternative approach is the Circles of Sustainability).
4. Globally shared policies are very difficult to reach, making it, in most cases, impossible to apply such measures. For example, hardly people might be willing to give up part of their well-being to replenish lost ecosystems.
5. It's very difficult for companies to recognize the benefits of the TBL. The fact that there is no unique way to measure in monetary terms the benefits for society and the environment is one of the main weaknesses of the Triple bottom line framework. So, it is difficult to find an unique application.
6. TBL is viewed as something that undermines ecological sustainability because it equates ecological and environmental priorities. This is wrong because in reality both economic and social viability is dependent on environmental well-being. Also, the TBL is viewed as an attempt by exploitative corporations to avoid legislation and taxation and generate a fictitious people-friendly & eco-friendly image for PR purposes called “greenwashing”.
7. While on the one hand the concept of the TBL can be attractive, on the other hand the risk is to not considerate that the non-generation of value for society is at the same time an absorption of value. The attempt to create the third bottom line for the environment can lead companies to fragment the bottom line related to the social dimension (Kaufman, R., *A Manager’s Pocket Guide to Strategic Thinking and Planning*, Amherst, MA. HRD Press, Inc, 2011.

Accordingly, Elkington does not speak explicitly of governance, but he argues that a good *equilibrium* of these areas is necessarily the consequence of good governance.

One of the most common framework used by the UN to represent this concept is:

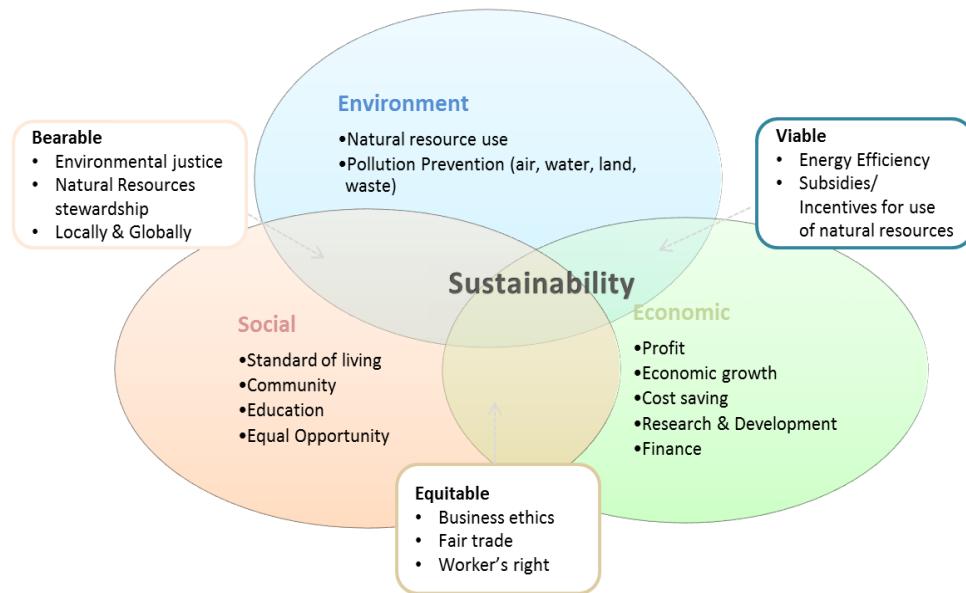


FIGURE A_IMAGE ADAPTED FROM THE 2002 UNIVERSITY OF MICHIGAN SUSTAINABILITY ASSESSMENT UNIVERSITY OF MICHIGAN.

Bernardez, M., Achieving Business Success by Developing Clients and Community: Lessons from Leading Companies, Emerging Economies and a Nine-Year Case Study, Performance Improvement Quarterly 18, 2005.

The meaning is that companies should give greater importance to the various needs and interests of their stakeholders, rather than maximizing only shareholder utility. The 3BL model has fostered the criticality and importance of ESG issues and the responsibility of the impacts of business activities.

The sustainability concept came to be and was developed from the international challenges especially within the UN and business networks initiatives¹⁷, focusing on its relevance in the financial sector, through 'Principles'. The UN sustainability principles are neither philanthropy nor simply a cost for societies, but rather a value system that gives the opportunity to benefit from intangible capital as a support for the economy.

When stakeholders share the UN principles of sustainability, a relationship is generated which becomes an intangible asset as they put pressure on the other stakeholders to also adopt a sustainable strategy.

Every stakeholder has a stake that can be only economic (i.e. more profit, less cost), social (e.g. respect of local people), environmental (e.g. less pollution) or combinations of these three interests.

In fields such as law, management and human resources, the stakeholder theory¹⁸ is challenging the usual frameworks, by suggesting we put stakeholders' needs at the heart of any action or strategy.

An economic sustainable project is the result of interactions among stakeholders. In order to realize it with a sustainable approach the project must consider environmental, social and governance factors.

Therefore, sustainability is a common stake, and generates intangible and tangible value and a good reputation. These conditions create competitive advantages for those who invest in sustainability. In particular, tangible value can consist in benefits (or lower costs) also given by financial intermediaries

¹⁷ Some examples might be: UN Global Compact Principles (2000), IFC Equator Principles (project financing 2004), UNEP FI Global Compact Principles for Responsible Investments (2006), UNEP FI Principles for Sustainable Insurance (Rio +20, 2012).

¹⁸ The term stakeholder appeared for the first time on an internal memorandum of Stanford Research Institute (1963), *representing those groups without whose support the organization would cease to exist*. Therefore, Freeman developed the stakeholder theory and thus this concept began to be used in many different contexts. Moreover, stakeholders are individuals or groups (or organizations) that affect or are affected by the organization (company or project) and its processes, activities, and functioning. It is possible in a broader mapping of a company's stakeholders to assume other entities, such as government legislative bodies, government tax-collecting agencies, industry trade groups, professional associations, NGOs, (inter-)national communities, global community and future generations.

which recognize a lower risk profile, and the capacity to generate and maintain value over time¹⁹. This advantage increases opportunities for more investments in sustainability.

¹⁹ For example, insurance companies are able to trigger a sustainable approach: the effort of industry companies to invest in sustainability, which could be seen only as a cost in the short run, is awarded by a lower cost of insurance products. Accordingly, the majority of the financial products that are sold are a result of analysis based on creditworthiness (see Pedol M. - Cabot T., *Quantify Sustainability: a new factor inside insurance pricing*, 2015, published by Argo Group International Holding, Ltd.

Section 2

HOW TO INTRODUCE SUSTAINABILITY IN DECISIONS? THE REAL OPTIONS

The idea behind is to have a quantitative tool helpful in measuring the impact of being sustainable when taking decisions. The starting point could be to use the real option model²⁰. In general, a real option values a choice associated to business investment opportunities and focuses on tangible and/or intangible assets. We can use a real option to value the investment in sustainability as a risk mitigation technique. The reason is that management can greatly affect the valuation of investments (or additional investment), and therefore, can demonstrate the value of sustainability for a project in comparison to that of an unsustainable project.

The real option approach is developed under some assumptions: uncertainty creates opportunities but only if management assumes adequate decisions. This is true if it is possible to complete an identification of the sources of uncertainty, of the data collection and of the choices/options. The aim is also to find optimal decision rules with lower exposure to downside risk.

THE OPTION OF SUSTAINABILITY

Now we want to introduce the “sustainability option” (or the Real Option for Sustainability/ option of sustainability). This real option is not classified as a typical real option²¹. Indeed, we have a particular new opportunity: a company wants to invest in a project and its Management has to decide to invest in sustainability or not. The Management has two choices. It can either just finance a basic or unsustainable project or add financing for sustainability with

²⁰ Stewart Myers of the MIT Sloan School of Management wrote about real options in 1977. In the recent years, this approach has developed an increasingly more important position in the financial markets.

There are real options when there is the possibility to choose different strategies during the project’s life and, as a consequence, to change the size, opportunity and risk of a project’s cash flows. So, these types of options can add (or deduct) value to the project analysis. Moreover, these options are a good tool to make a project flexible in relation to the market changes and because they study each scenario identifying the most appropriate corporate action.

²¹ Hull, J., *Options, Futures and other Derivatives*. New York: Prentice Hall, 19936, ed. 2012. Trigeorgis, L., *Real in Capital Investment. Models, Strategies and Application*, Greenwood Publishing Group. 1995.

Brasch, M. A., *Real Option in practice*, Wiley Finance, New Jersey, 2003.

the aim of preventing or avoiding loss from adverse events. In this context, we consider sustainability as risk mitigation. Therefore, the Management's decision is to include sustainability factors and to finance them; in essence, they are choosing to cover the risks correlated with ESG factors. Here, real options are not only a tool to value a choice, but also a risk management instrument. In this context, the link between financial options and a real option is straighter: both can be viewed as hedging functions. Thus, the option of sustainability can be used to value an added investment that covers risk. In this case, the option follows a put option 'logic' where the time to maturity is the time of the coverage. The holder/management obtains the right to establish a threshold of prevention against a specific adverse event at a given time. In particular, it follows the logic of a long put because the holder fears adverse events over the life of the project.

Another way²² to classify real options is the nature of the opportunity, such as: option to grow, contraction option, flexibility option.

Now, we introduce a new category connected to risk mitigation. Indeed, every project has its probability of failure: if a material adverse event occurs the project will potentially produce a loss. Taking as an example environmental risks, environmental adverse events can generate disasters (natural or man-made) that are often catastrophic, so such events can lead to the default of the company.

If we consider these events, we can value the opportunity of sustainability as an investment and not as a cost. The real options approach gives prominence to the downside risk: uncertainty can make people appreciate the additional value of sustainability, especially to those who are poised to take advantage of it.

For the sake of clarity, we offer the example of a European real option. In our example we consider a Company that is considering an important project. The cost of the project is X, and the future cash flows are uncertain, so we have real-world probabilities of certain events happening - or not happening:

- $p \in [0,1]$ is the probability to have the best scenario and generate a positive cash flow of S million after T years.
- $(1-p) \in [0,1]$ is the probability of a negative event connected with an ESG factor; in this state the cash flow is negative for Z after T years. So, there is a chance that the project will generate a loss.

If the Company invests in sustainability the initial cost of the project is greater for C, but if the adverse event occurs the loss is G less than Z.

²² Triantis, A. J., *Real options and corporate risk management*, Journal of Applied Corporate Finance, 2000.

The discount rate is the minimum return that a Company must earn on the project that requires a return for the riskiness. It is the Company's cost of capital or weighted average cost of capital (WACC) that represents the rate that the company is expected to pay on average to all its security holders.

In order to assess the optimal investment, we now consider NPV analysis, the tree analysis and Black–Scholes methods as models to evaluate real options.

Therefore, the project data is:

Initial cost of project=	X
Initial cost of security/sustainability=	C
WACC=	i
Cash-in of the project=	S
Catastrophic loss without sustainability=	$-Z$
Loss with sustainability=	$-G$
Maturity=	T

where $-G \geq -Z$.

NPV method

According to NPV analysis, we proceed with the valuation of the expected cash flows (CF) without the cost of sustainability and, including the initial cost, we calculate the net present value (NPV) at WACC as the discount interest rate:

$$NPV(i, T) = \sum_{t=0}^T \frac{CF_t}{(1+i)^t}$$

That is:

$$\text{Basic Expected NPV} = [p * S + (1-p) * (-Z)] * v - X,$$

where v is the discount factor.

According with NPV method, the rule is:

- if $NPV > 0$ the investment is convenient (profitable).
- if $NPV < 0$ the investment is not convenient (profitable).

By considering the value of the option, the assessment analysis would be done through a what-if analysis of the NPV: how NPV changes when there is variability in its variables.

With Net Present Value, we cannot value the benefits of the sustainable option, so we need to use another technique because we analyze only a part of the project as the following graph shows.

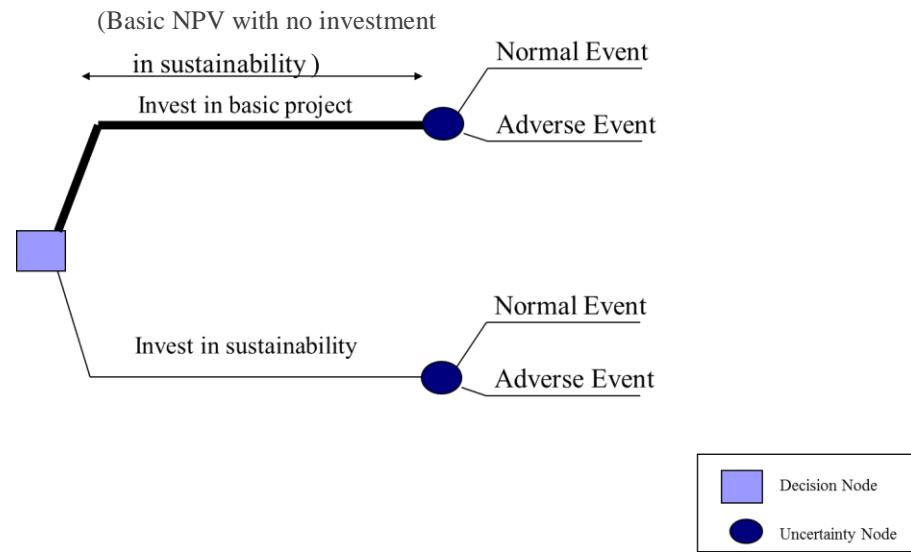


FIGURE B_UNCERTAINTIES AND STRATEGIC ALTERNATIVES.

Tree analysis of the option of sustainability

We can explain by scenario analysis the choices that we can take: to invest in a project with a sustainable strategy or not. First, we describe the scenario for the basic project and the scenario for the sustainable project.

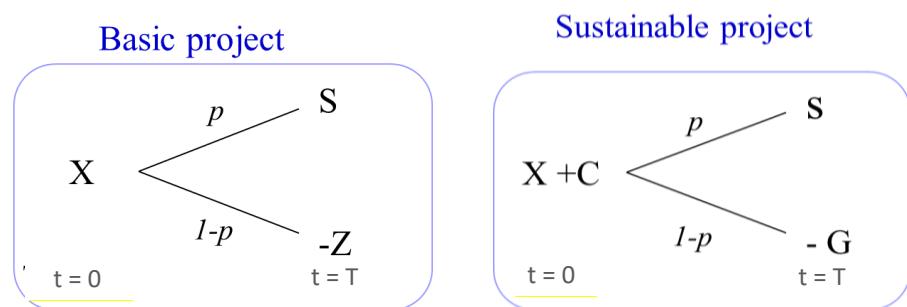


FIGURE C_TREE ANALYSIS OF BASIC AND SUSTAINABLE PROJECTS.

where, we recall that $-G \geq -Z$.

The aim of the second step is to evaluate the expected value of NPVs, such as:

$$\text{Basic NPV} = [p * S + (1-p) * (-Z)] * v - X$$

$$\text{Sustainable NPV} = [p * S + (1-p) * (-G)] * v - X - C$$

We can obtain the option pay off as the difference between the cash flows of the sustainable project and the basic project. The initial cost of the option is the cost to invest in sustainability. In the basic scenario (with probability p), the pay-off is null because the cash flows are the same for the two projects that we are evaluating. In the worst case scenario (with probability $(1-p)$), there will be the cash-in opportunity due to the reduced impact of a major loss due to better security.

Payoffs to Real Option Holders (e.g. the Management) are:

$$\begin{cases} 0 & \text{if the situation is normal} \\ -G - (-Z) = (Z - G) & \text{if the adverse event occurs} \end{cases}$$

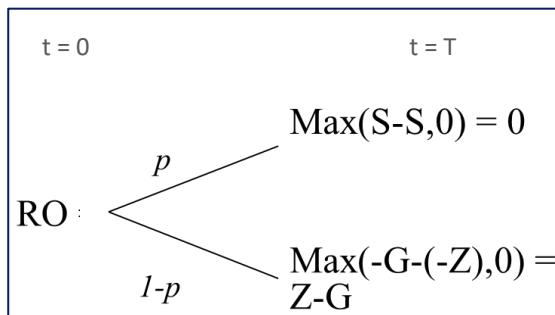


FIGURE D_SUSTAINABLE REAL OPTION TREE ANALYSIS.

Thus, it is possible to calculate the value of the real option (RO):

$$RO = [(1-p) * (Z - G)] * v - C$$

and the real option pay off is equal to $\text{Max}[Z - G, 0] - C$.

Black–Scholes method

Now we adopt the Black and Scholes method to price the real option²³. This model has been used for financial instruments²⁴ and in the recent decades has

²³ Ibidem.

²⁴ Hull, J., Options, Futures and other Derivatives. New York: Prentice Hall, 19936, ed. 2012.

Trigeorgis, L., Real in Capital Investment. Models, Strategies and Application, Greenwood Publishing Group. 1995.

been adopted within the real option world. However, it is worth noting that applying Black and Scholes model requires that the random variable representing the underlying, i.e. the value of the unsustainable project, follows a log-normal distribution.

Using the information of the project we can attribute a new meaning to the five variables of the Black-Scholes model, so to evaluate the volatility and riskiness of the project. The option to invest in a sustainable project aims to hedge the risk of a loss linked to ESG factors of a specific project with a maturity of T years. We assume that the time until the option expires in the project is the same and the discount rate represents its time value of money. The option to invest in a sustainable project can be represented as a European put option where, for each t , the stock price is the value (V_t) of an unsustainable project's cash flows (gross of X). We consider the value (V_t) of a project's cash flows, if beforehand negotiated, as the best estimate of its 'market value' at time t ; while, the exercise price is equal to the certainty equivalent of a sustainable project's cash flows, assuming risk neutrality. The idea is that the possibility of a catastrophic loss event exists and that the Management is willing to invest C to hedge against risks, so that the expected value of the project is higher in comparison with of the basic project.

The final step is to find the value of the specific sustainable investment.

To summarize, we have:

Amram, M. – Kulatilaka, N., Real Options. Managing strategic investment in an uncertain world, Harvard Business School Press, Boston, 1999.

Copeland, T. – Antikarov, V., Opzioni Reali: tecniche di analisi e valutazione, Il Sole 24 Ore, Milano, 2003.

Damodaran, A., The promise and the peril of the real options, Stern School of Business, New York, 2005.

Dixit, A., Pindyck, R., Investments under uncertainty, Princeton University Press, Princeton, 1994.

Option	Investment in Sustainability
Stock price _t	Present value of unsustainable project's cash flows
Exercise price	Certainty equivalent of sustainable project's cash flows
Time to expiration	Length of time the project
Risk-free rate of return	Time value of money
Variance of returns on stock	Riskiness of the project

FIGURE E_ELEMENTS OF THE OPTION.

Thus, the option in sustainable project is:

$$RO(sP, T) = \max [E(sP, T) - V_T, 0] - C$$

Making a kind of comparison with the financial put option, in the sustainability put option, the strike price is equal to the certainty equivalent of the sustainable cash flows in T and the underlying is the value in T of the basic project. The company gains the value produced by the protection. The catastrophic losses caused by a specific event are limited thanks to the project prevention.

The elements of the formula are:

sP = sustainable Project

$E(sP, T)$ = certainty equivalent of the cash flows of the sustainable Project

V_T = value of the unsustainable Project in T , i.e. the final cashflow of the unsustainable project (cash-in or catastrophic loss) in T

C = initial cost of investing in sustainability

If the company implements the sustainable project, it will take advantage of the cover. We need the risk neutral probability to use free-risk discounting, so we

calculate the value of the real option analyzing sensitivity in respect of the investment volatility.

It is important to examine the sensitivity of the results with reference to the standard deviation of the project because this sensitivity can change the evaluation of the project.

We have that the value of the sustainable project is equal to the NPV of the basic project plus the value of the sustainability option and when the project's risk is higher, the value of the real option increases as well.

Section 3

CASE STUDY BRITISH PETROLEUM**

** Please consider that some figures here presented could be reasonable approximations because the intent of the author is to explain the underlying reason of the Real Option described in the Section 2 and not give detailed information of the event here presented.

In order to test our model for the Sustainability option in surety we are going to analyze the case of the British Petroleum (BP) oil spill of 2010 better known as the Deepwater Horizon spill. We take into consideration the causes and the economic impact of this huge disaster that hit the company directly and caused large damages in environmental, social and economic terms. Application of the Sustainability option shows that if the company had implemented a sustainable strategy considering all the variables connected to the operation, it could have avoided this terrible event. This approach led the decision makers to choose the best safety strategy even if there were higher costs for exploratory drilling. These costs could have been more sustainable considering the whole project and the connection with the Mexican Gulf environment and the economy of the four key US States in the Gulf.

OVERVIEW OF THE BRITISH PETROLEUM AND THE DEEP WATER HORIZON PROJECT

Prior to April 2010, BP was one of the six largest multinational companies in the oil sector. BP's stock is trading on NYSE at \$60.57 and it is the largest company listed on the London Stock Exchange. The company was founded in 1909 as the Anglo-Persian Oil Company (AIOC) after eight years of searching by the Englishman William Knox d'Arcy struck oil in Iran. After WW1 the British government bought a stake of 51% in the nearly bankrupt company with the idea that the sector would become of strategic importance for the army and the future of the country.

The British government's majority ownership lasted until 1970 when Prime Minister Margaret Thatcher started to sell shares of the company to spur better productivity. In 1987 the government sold its last remaining 31% given the continuing decline in the performance and share price. In 1992 BP registered a full-year loss of \$811 million. A revised strategy of cost reduction was

implemented and thanks to the merger with AMOCO in 1998 and ARCO (the former Atlantic Richfield) the trend was finally reversed.

The Organizational structure changed in the late 80's and early 90's when Robert Horton was appointed CEO of the company. With the aim to cut costs of control he removed several layers of management. Horton transformed hierarchically structured departments into smaller, more flexible teams charged with maintaining open lines of communication.²⁵

Horton transferred decision making upstream and downstream from the center. The onsite asset managers²⁶ were in charge of the performance targets of the site and were managing with all the authority and responsibility. This model of "Asset federation" was taken on charge when John Browne took over as a CEO in 1995.

One of the weak points of the model was that there was not any exchange of experience about risk management among the various exploration sites as every manager was completely independent.

In 2001 BP started to change and improve its image under the CEO John Browne with the new tagline "Beyond Petroleum". The company invested in alternative energies such as solar cells and wind mills. The investment in alternative energy between 2005 and 2009 amounted to \$4 billion.

In 2007 Tony Hayward replaced John Browne as CEO and changed the "Beyond Petroleum" strategy to a far reaching and different strategy which was based on "focus like a laser on safety issues, put the brakes on growth and slash production targets"²⁷. In the attempt to cut the company's transactional costs, Mr. Hayward adopted a less risk adverse approach in the belief that too many people were involved in decision making.

On the safety site BP reported 63 incidents for misconduct since 1995 (Sheppard, 2013). On March 23, 2005 one of the largest accidents happened in Texas where the explosion at BP's City Refinery killed 15 people and injured 180. It resulted in a financial loss exceeding \$1.5 billion. On March 2006 a second disaster occurred in Alaska's Prudhoe Bay where more than 200.000 gallons of oil poured into the sea from a corroded hole in the pipeline. It was the largest oil spill on record in Alaska. After an inspection it was determined that a large section of the steel pipeline had become very thin and corroded.

²⁵ BP After Horton, The Economist, July 1992.

²⁶ Site manager is the figure in charge to manage a single well site called asset.

²⁷ Hayward, T., BP 2008 strategy presentation, BP Publication, April 2010.

In relation with these last incidents BP commissioned several independent reports to detect causes. The most important of these reports was the Baker report, which was commissioned by James Baker, former secretary of State following the explosion in Texas City. The result of Baker report was that it underlined the lack of safety culture in the company workforce:

“The Panel’s refinery-level interviews, the process safety culture survey, and some BP documents suggest that significant portions of the U.S. refinery workforce do not believe that process safety is a core value at BP. As many of the refinery interviewees pointed out, and as some BP documents and the process safety culture survey seem to confirm, one of the reasons for this belief is that BP’s executive and corporate refining management have not communicated a consistent and meaningful message about the importance of process safety and a firm conviction that process accidents are not acceptable. The inability of many in the workforce to perceive a consistent and meaningful corporate message about process safety is easy to understand given the number of “values” that BP articulates:

- *BP’s 18 “Group values,” only one of which encompasses health and safety—the company’s broad, aspirational goal of “no accidents, no harm to people, and no harm to the environment.”*
- *Four “Brand values,” which BP claims, “underpin everything we do”: being performance driven, innovative, progressive, and green. None of these relates to safety.”²⁸*

In response to the Baker report and the others that followed it BP took four major corrective actions to regain control of this glaring lack of safety:

- Leader Visibility: The BP’s CEO met with the company leaders to reinforce the safety message. Safety training and workshops were done at all levels of the organization with all American employees.
- Review of employee concerns: Retired United States Judge Stanley Sporkin was put in charge of establishing a communication program wherein all employees could voice their concerns.
 - Auditing: The Safety and Operation organization was in charge to conduct an internal and enhanced audit to assess the compliance against a six point action plan for sustained development.
 - Resources for plant, equipment, and systems: \$7 billion program was put in place to substitute infield pipeline in Alaska and to repair US

²⁸ Baker, J., et al., *The Report of the BP U.S. Refineries Independent Safety Review*, January 2007 pp82-85.

refineries. And another \$300 million was announced for a process safety in refining program.

Between June 2007 and February 2010, 97% (829 of 851) of the willful safety violations were handed down by the Occupational Safety and Health Administration to the two BP-owned oil refineries in Texas and Ohio.²⁹

THE MACONDO WELL

The Macondo well is located 52 miles south of the port of Venice, Louisiana in the Gulf of Mexico. The well is located at a depth of 1524m below the sea level. Its exploitation appeared to be problematic because of the high level of natural gas. Notwithstanding the problems for drilling in ultra-deep water, it was decided to proceed with the Macondo well due to the high price and projected profitability of crude oil. The expectation for a deep water well was up to 10.000 barrels a day.

BP acquired concession from US authority and started the Macondo well on October 2009. A delay of a couple of months was recorded due to the passage of hurricane Ida. On September 2009 after a BP audit on the Deepwater Horizon Rig it was determined that the Rig needed at least 390 repairs with estimated 3500 hours of labor.

On February 3, 2010 the drilling operation started. BP leased the Deep Water Horizon Rig from Transocean at a daily rate of approximately \$500,000. A first estimation foresaw 51 days to drill the well at a budget of \$96 million. By April 20, 2010 the drilling was still not completed and had already exceeded 80 days, thereby far exceeding the initial budget.

The Deep Water Horizon Rig was just an exploratory vessel. Once the well was drilled it would have to be tapped and a second facility would be brought into place to exploit the well.

Closing the Macondo well was to be particularly difficult due to the deep water and the high levels of natural gas. A series of mistakes took place in choosing the techniques and the equipment due to competing interests of cost, time and safety. The result was the largest tragedy in Ocean drilling.

²⁹ Thomas, P.- Jones, L. A. - Cloherty, J., Ryan, J., *BP's Dismal Safety Record*, ABC World News, 2010.

THE DISASTER

On April 20, 2010 the Deepwater Horizon Rig working on Macondo well exploded. Of the 126 workers on board, 17 were injured and 11 killed. The rig burned for 36 hours, consuming 700.000 gallons of oil that were on board, leaving a trail of smoke of over 48km. The Deepwater Horizon sank on April 22, taking with it the top pipe of the well and parts of the system that were supposed to prevent blowouts from occurring.³⁰

The Macondo well was finally capped on July 15, 2010 after discharging nearly five million barrels (around 779 million liters) of oil into the waters of the Gulf.

THE LOSS BY THE NUMBERS

The disaster resulted in 11 deaths and 17 injuries among Deepwater Horizon crew. BP has paid \$28 billion of damages with the risk of a final toll of \$50 million.

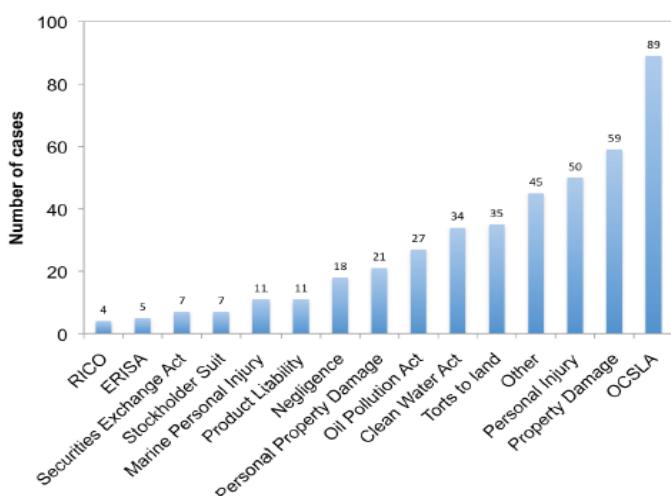


FIGURE F _ DEEPWATER HORIZON OIL SPILL LITIGATION³¹.

All the Federal waters were closed for drilling operations for a long period. Around 2,000 rig worker jobs were lost during this time. The drilling operators reduced their spending by as much as \$1.8 billion. The total cost in lost jobs for the Gulf Coast amounted to somewhere between 8,000 to 12,000.

³⁰ Ingersoll, C. - Locke, R. M. - Reavis C., *BP and Deepwater Horizon disaster of 2010*, MIT Sloan Management, 2011.

³¹http://sero.nmfs.noaa.gov/deepwater_horizon/index.html



FIGURE G_ CLOSURE OF FEDERAL WATERS³².

BP share price collapsed from \$60.57 on April 15, 2010 to \$ 27.02 on June 25, 2010. Frustration spread among shareholders as the different attempts to cap the well failed until the middle of July.

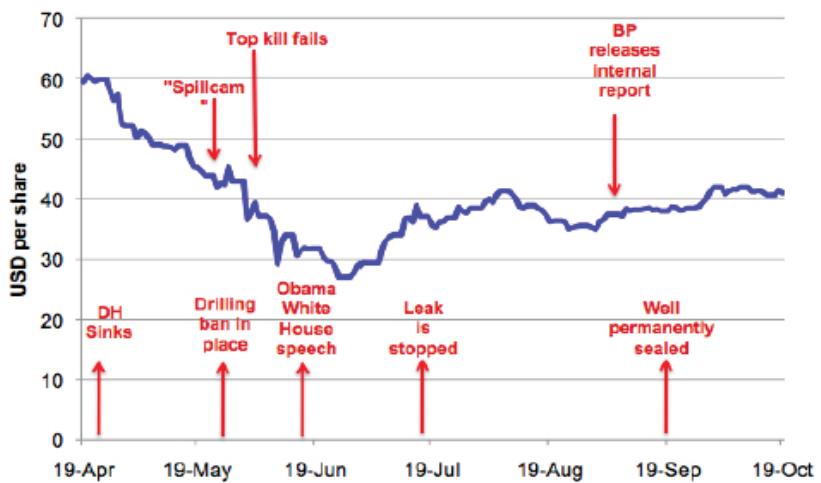


FIGURE H_ BP SHARE PRICE³³.

The environmental damage of the spill extended to 1,770 km of shore line impacting 25 national wildlife refuges. Four States were heavily hit by the leak: Louisiana, Mississippi, Alabama and Florida. The recovery time for crude oil pollution is estimated in 50 years. From 2010 to 2012, 817 cases of death of bottlenose dolphins were reported compared to a normal rate of reported deaths of 100 per year.

³²Ibidem.

³³Ibidem.

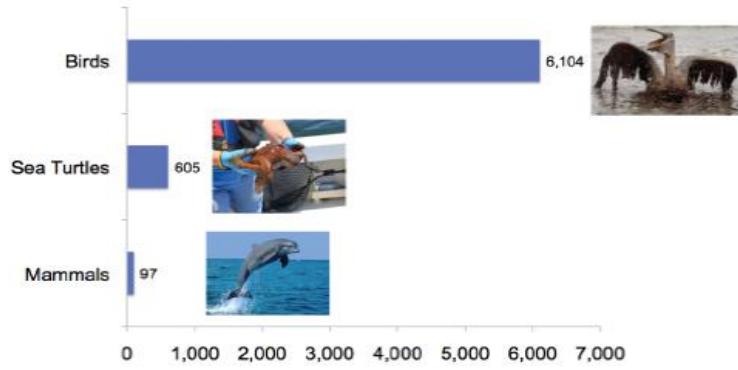


FIGURE I – MARINE LIFE MORTALITY³⁴.

In direct cost the sinking of Deepwater Ocean rig represented \$560 million for Transocean and many insurers including the underwriters at Lloyd's of London. Another impact of this event was the increase of the cost of oil rig insurance by as much as \$10,000 to \$15,000 per day.

In economic terms many different sectors were severely impacted by this loss: fishermen, shrimpers, oystermen and many people involved with the tourism sector. The total lost jobs terms in the Gulf region was estimated at 250,000 jobs.³⁵

In terms of oil, 4.9 million barrels were lost at an average cost per barrel of \$74.81 (April 2010) this loss amounted to \$374 million.

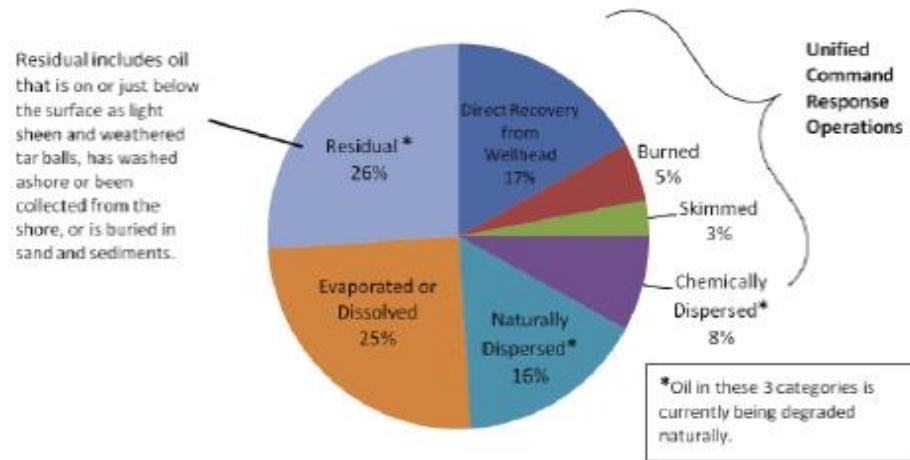


FIGURE J – DEEPWATER HORIZON OIL BUDGET: BASED ON ESTIMATED RELEASE OF 4.9M BARRELS OF OIL³⁶.

³⁴ Ibidem.

³⁵ Standard and Poor's Industry Surveys: *Oil & Gas, Production and Marketing*, August, 2010.

³⁶ Ibidem.

AN APPLICATION

In this exercise we consider a Company that is planning to drill an oil well. We take into consideration the following figures from BP project in Macondo Well:

- 10.000 barrels a day is the potential exploitation of the Macondo well. BP decided to drill the Macondo Well situated at a depth of about 1,500 m below the sea surface. The decision to exploit a well so deep was taken considering the high price of oil in that period, which thereby allowed the company to cover high cost of exploitation. The projected high performance of the Well compared to some thousand barrels per day of the shallow water wells was also a major motivating factor to move forward with this project.
- \$80 per barrel was the oil price on April 2010
- \$96 million was the cost of BP operation planned for 51 days
- \$48 billion was the projected loss that BP sustained
- \$169,298.39 was the amount BP saved by deciding not to test the cementing of the well effectively discounting the high risk for gas channeling. They also would have saved \$500.000 if they were able to complete the operation one day ahead of the projected date.

We are considering these figures to test our model: the cost of the project is \$96 million, but the future cash flows are uncertain. Company estimates a 0.3% probability that an environmental disaster occurs. Therefore, there is a 99.7% probability to have an operating well producing \$1.8 billion; considering 10.000 barrels a day for thirty years. In case of a disaster, a total loss of -\$43 billion will be recorded in the cash flow of the first year. The weighted average cost of capital is 15%.

➤ Inputs

All the inputs are resumed in the following tabs:

WACC=	15%	Catastrophic loss without sustainability	\$43.000
Risk-free rate =	2,5%	Catastrophic loss with sustainability	\$0
Initial cost of project=	\$96	Loss failure	\$43.000
Initial cost of security/sustainability=	\$1	Cash-in of the project	\$1.800

➤ Net Present Value

DCF Analysis

Expected cash flows (in millions) without cost of sustainability

Probability	Cash Flow	Prob. x CF
99,7%	\$1.800	\$1.794,60
0,3%	(\$43.000)	(\$129,00)
Expected CF =		<u>\$1.665,60</u>

Our assumption is that the positive cash flow is equal to the present value as turnover of the oil well (taking into account the operating cost, it does not matter if we put the positive CF equal to the NPV³⁷).

The Net Present Value of the drilling operation without sustainability costs is positive.

NPV (in millions) without cost of sustainability

Time Line	Year	0	1
	Expected CF	(\$96)	\$1.665,60
NPV =			\$1.352,35

If we have to stop at this assessment, we would not be able to incorporate the value of any investment in sustainability. In fact, considering that investing in sustainability has an additional initial cost, the investment would not be convenient.

➤ Decision Tree Analysis for Option of sustainability

Now we suppose to have the option to invest in sustainability, the option can be seen as a put option as described in section 2, then:

³⁷ In this scenario, the example is true also if the cost is up to 90% of the turnover.

1.1 Project without investment in sustainability

	Future Cash Flo		NPV of this		Probability
	Year 0	Year 1	Scenario ^a	Probability	x NPV
NO Sust	OK → KO ↘	0.997 0.003	-\$96	\$1.800 \$1.469,22 99,70% \$1.464,81	
			-\$96	-\$43.000 -\$37.487,30 0,30% -\$112,46	
					<u>100,00%</u>

Expected value of NPVs = \$1.352,35

Standard deviation = \$2.130,53

Coefficient of variation = 158%

The unsustainable project has a Net Present Value of \$1,352.35 million and a coefficient of variation (standard deviation/expected value of NPVs) of 158%.

1.2 Project with investment in sustainability

	Future Cash Flows		NPV of this		Probability
	Year 0	Year 1	Scenario ^d	Probability	x NPV
YES Sust	OK → KO ↘	0.997 0.003	-\$97	\$1.800 \$1.468,55 99,70% \$1.464,14	
			-\$97	\$0 -\$96,67 0,30% -\$0,29	
					<u>100,00%</u>

Expected value of NPVs = \$1.463,85

Standard deviation = \$85,60

Coefficient of variation = 6%

The project with \$0,669 million dollar investment in sustainability, has a Net Present Value of \$1.463, 85 million and a low coefficient of variation, equal to 6%.

1.3 INVESTMENT IN SUSTAINABILITY

	Future Cash Flows		NPV of this		Probability
	Year 0	Year 1	Scenario	Probability	x NPV
Invest Sust	OK → KO ↘	0.997 0.003	-\$1	\$0 -\$0,67 99,70% -\$0,67	
			-\$1	\$43.000 \$37.390,64 0,30% \$112,17	
					<u>100,00%</u>

Expected value of NPVs = \$111,50

The value of the option (or *option premium*) obtained through the difference of the Net Present Values of sustainable and unsustainable projects is positive and equal to \$111.50 million.

Consequently, the value of the sustainable project is equal to the NPV of the unsustainable project plus the value of the real option. The sustainable project is therefore preferred not only because it has a higher NPV but also because it has a much lower volatility in the cash flows than the unsustainable project.

➤ Black–Scholes method

In this paragraph, we can calculate the real option with Black and Scholes method where the CE of the cash flows of the sustainable project is equal to the expected value of the sustainable project's cash flows. But, we should assumed either a binomial or a log-normal distribution and we should assumed to have enough data to calibrate the parameters of the pricing models. Nevertheless, when dealing with environmental sustainability we often challenge extreme events and, due to the scarcity of available data, probability distribution could be better modelled by means of the Extreme Value Theory³⁸. However, that was not in the scope of the paper which aims to focus on the real option for sustainability.

³⁸ Embrechts, P. & Klüppelberg, C. & Mikosch, T. (1997). Modelling Extremal Events for Insurance and Finance, Springer

Zhou, C. (2009). "Existence and consistency of maximum likelihood estimator for the extreme value index". Journal of Multivariate Analysis 100:794–815.

Zhou, C. (2010). "The extent of the maximum likelihood estimator for the extreme value index". Journal of Multivariate Analysis 101:971–983.

CONCLUSION

With this paper, we demonstrate that we can actually value sustainable investment when it is a risk mitigation strategy.

In this way, we can correctly evaluate a 'sustainable' project, creating a 'trade-off' between the need to adopt an approach that takes into account the interests of all stakeholders and the interest in the development of economic initiatives by obtaining profits.

Sustainability allows considering stakeholders' interests through ESG factors and it can generate value.

The Value of economic initiatives can be evaluated introducing a real option approach, the Real Option for Sustainability. Accordingly, it is possible to evaluate the project, in conditions of uncertainty and flexibility, as well as the current value of savings in case of future losses, considered at the time when the option is exercised.

This is an innovative tool useful to select optimal strategies for the benefits of Management and, in general, whoever is interested in evaluating it. Therefore, the choice is to invest, or not, in a sustainable project.

Through the support of the case study, we have demonstrated that the sustainable project has an added value: it is equal to the NPV of the unsustainable project plus the actual value of the Real Option for Sustainability.

For the purpose of this paper we have investigated one-year coverage, but Sustainability Real Option can be developed also as an American Real option since the right of the option could be exercised in any time.

This option is a hedge against adverse events; therefore, it reduces the relative volatility of the project's cash flows. The evidence is that when the riskiness of the project increases, so does the Real Option value. Therefore, the Real Option for Sustainability is a risk mitigation instrument.

With the contribution of this model, we would also like to encourage the development and the adoption of instruments useful for estimating competitive advantages for those who invest in sustainability. In so doing they recognize a lower risk profile, and the capacity to generate and maintain value over time; value, that is not only intangible but also actually tangible.

Disclaimer: The author declares that there is no conflict of interest.

This paper does not necessarily reflect the official policy or position of the Generali Group on the subject here reported.

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