

# Scenario planning and real options analysis in integrated risk management process

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## Abstract

The paper shows an integrated theoretical concept of preparing quantitative risk assessment using real options that results from the qualitative method which is scenario planning and its modification. Scenario planning is a very useful tool to describe the factors resulting from environment that influence the company. It is used to translate organizational learning capabilities into precisely planned operational responses to react to and then recover from an exogenous shock. Those scheduled activities should be evaluated from the perspective of financial effectiveness and value creation. Therefore description of the environment in the form of scenarios integrated with the real options valuation is an interesting theoretical concept of risk management that requires to be tested and researched in the future.

## Key words

Scenario planning, risk management, operational risk

**JEL Classification:** G11, G17, G32

## 1. Introduction

The main purpose of the paper is to indicate a possibility of incorporating scenario planning and real options analysis into risk assessment and measurement in corporate practice. Scenario planning concept is deeply rooted and has a long history in strategic management research and practice. It is a qualitative method. Its main focus is put on creating corporate strategies on the basis of future scenarios of company's environment. The concept of scenario planning was developing fast in seventies, mainly on the governments level with further implementation on corporate level in eighties. There were created as many frameworks of constructing scenarios as consulting companies that appeared on the market, especially in USA, UK and France. There is a noticeable gap in the research on strategic financial decisions and investments decisions made on the basis of scenarios of company's future. In financial management, mainly in financial planning, scenario analysis is known as indirect risk assessment and analysis method, where impact of simultaneous changes of assumptions on investment appraisal or valuation is being tested (Pluta, 2010, pp. 36-38). This approach focuses on analysis of different variants of financial plans with changed assumptions rather than financial simulations dependent on various scenarios of company's future environment. In this paper author makes an attempt to show that incorporating scenario planning into financial planning and investment decision can be a useful tool of assessing, measuring and reducing operational risk. Quantitative way of assessing and measuring risk on the basis of scenarios could be done by implementing real options analysis.

Real option analysis is set in the finance research and only lately has started to be applied in business practice. Real option analysis has a quantitative approach towards investment projects available to a company. Using option valuation models manager can determine the

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potential for value creation from maintaining flexibility under uncertainty (Miller, Waller, 2003, p.94).

In the first part, the paper provides an overview and summary on scenario planning work, and its contribution to assess risk factors from general market perspective and from organizational level. The second part gives the overview on real option analysis and different perspectives on risk assessment and management in strategic management and in finance.

The concept of framework integrating scenarios and real options was primarily presented by Kent D. Miller and H. Gregory Waller (2003), than by Roger W. Mills, Bill Weinstein and Giampiero Favato (2006). One of the purposes of those studies was to make real options analysis more applicable in business practice. Author of this study worked on an integrated valuation process that was based on scenario approach (which is described in unpublished PhD thesis). Major postulate was to maintain cohesion between assumptions of sales forecast made on the basis of scenarios and assumptions of financial forecasts for company valuation. Considering the results of literature research and own author's research results on integrated valuation process the framework for risk assessment, measurement and management is being discussed and modified.

## 2. Scenario planning

The methodology underpinning the scenario planning recognizes that the environment is a complex system marked by intrinsic uncertainty that be best understood from the perspective of multiple and plausible futures (Burt et al. 2006, p.60).

Scenarios are not predictions, extrapolations, good or bad futures, or science fiction. Instead, they are purposeful stories about how contextual environment could unfold in time (van der Heijden et al. 2002). A proper scenario should consist of:

1. A description of a future end state in a horizon year – the combinations of uncertainties and their emergent resolution in the final point in the time in a particular scenario story.
2. An interpretation of current events and their impact on the future – the method of creating scenarios is designed to make sense of past events and their emerging in present. Additionally some of those past events may not yet have fully appeared as outcomes and it may be carried forward in time to the end of a certain scenario.
3. An internally consistent description of how the future world will function – an explanation based on causal logic of how a particular scenario unfolds from the past to the present and to the future. The story will show the dynamic interplay of predetermined elements and resolved uncertainties, showing how these factors interconnect and impact each other, revealing their logical consequences. Here knowledge in developing the causal logic of a story will be required.

Scenario planning is a process of structured thinking where the result consists of relatively complete description of examined object or system detailing maximum list of important factors that have impact on it. It is designed to be an organizationally based social-reasoning process where participants that come from the organization share their perception of the environment and are engaged in the whole process of building stories about the future that make sense and are logically connected.

According to M. Porter (1998) a scenario is a set of distinctive, internally consistent views of future world, that can be constructed in the way that probable range of results will be covered. Porter suggests to use scenarios in sector and competition forecasts, that could enable the company to make its own analysis and plan strategic actions in the situation when one of the scenarios is carried out.

There exist many concepts, kinds and types of scenarios. According to methodology of creating the stories about the future there could be distinguished three main categories (Bradfield et al. 2005):

1. Intuitive logics.
2. Probabilistic Modified Trends (PMT).
3. La Prospective.

From the very beginning the greatest distinctive parameter of those three scenario planning schools was the scope of application. In USA these were global scenarios and in France it was public situation and country level. Despite the diffusion of scenario methods to business practice, still in France they play the major role in public sector. Although M. Godet describes La Prospective as combination of system dynamics tools, it has been noticed that to a high extend it is the combination of intuitive logic and PMT methods (Bradfield et al. 2005).

There has been identified four main purposes of using scenario planning (van der Heijden et al. 2002): making sense of particularly incomprehensible situation; creating strategy; foreseeing the future; adaptive organizational learning. The most flexible group of methods being in the scope of intuitive logic school is applicable to realize all objectives from the listed ones. Whereas theoretically PMT and La Prospective can be applied in all four groups but in practice it is mainly implemented when there is a need to explain particular circumstances or to improve efficiency of operations or to make a strategic decision.

The overview of methods that work in practice was conducted by P. Bishop, A. Hines i T. Collins (2007). They identified eight groups of techniques of creating scenarios together with their modifications.

In the perspective of risk management scenario planning is perceived as a tool that is used to convert organizational learning capabilities into specific operational responses prepared to react to, and then recover from, an exogenous shock. The context in which companies operate, in most cases, is increasingly dynamic, uncertain and unpredictable. Those conditions require companies to adapt their strategy and implementation actions to re-align the company in a way that maximizes its value creation potential (Kang, Morris and Snell, 2007). Additionally to regular environmental threats that result from competitors actions, changes in demand and fashion for certain products or services, problems with suppliers and other factors companies can also experience challenges resulting from exogenous shocks (Haveman, Russo, Meyer 2001). Unexpected circumstances that may cause severe damages or problems, such as abnormal weather events, major global economic disruption, cyber security failures, risk of physical attacks (terrorists attacks) or unpredictable supply chain interruptions are examples of exogenous shocks. Firm can develop a combination of scenarios that create a hypothetical exogenous shock, followed by list of actions at each step of response towards it. Most of research on modifying core routines of companies in order to anticipate possible shock scenarios were conducted in USA. Although awareness of potential harm caused by exogenous shock exists not many companies actually prepare for such conditions. Results from Harvey (1993) cited by Worthington, Collins and Hitt (2009) showed that less than 50% of Fortune 500 corporations had implemented plans to react to or protect their organization from terrorist attack. The same authors also cite more recent survey presented in *2008 Continuity Insights/KPMG Business Continuity Management Benchmarking Survey*. Respondents note that 67% of firms indicate their business continuity program is well integrated with their crisis management program, but only 36% suggest that they are well integrated with their strategic planning activities. It signifies that plans of reacting to exogenous shocks are not constructed on the basis of long term strategic plans.

Although the problem of reacting by companies to exogenous shock situations is valid all over the world, it seems to be especially highlighted in USA, in terms of weather extremes

and terroristic attacks threats (after 9/11). The time after attack from 11<sup>th</sup> of September 2001 is even called a post-9/11 era (Worthington, Collins and Hitt 2009).

It is worth mentioning that scenario planning that prepares company for facing and recovering from exogenous shocks can increase its competitive advantage on the market as well as enriches its absorptive capacity and dynamic managerial capabilities, which results in providing knowledge benefits for the whole company. Examples can be found in the previously cited study of Worthington, Collins and Hitt (2009).

### 3. Scenario approach in risk management

One of the most important premises of forecasting by creating scenarios is to minimize the risk and uncertainty of business operations in the future. In practice it means lowering the uncertainty of decision making process. Very important insight on relation between constructing scenarios and strategic management is given by Armstrong (1985), who postulates that the process of scenarios writing, forecasting and creating strategy should be combined. Simulation of unfavorable environmental conditions should be the incentive for improvement of company's potential as well as strategy and key capabilities adjustment to prepare for the change of environmental conditions. The ability to adjust to the least favorable environment will be particularly valuable. It could reduce financial distress and other difficulties in company's operations. That process in more general way postulates that by planning and using scenarios companies should prepare for unfavorable conditions that in extreme case could become an exogenous shock.

Writing scenarios is qualitative method of risk assessment and management. Therefore risk is being determined in descriptive way. Eight steps of creating scenarios can help to structure this group task in order to identify exposures to operational risk in a company (Burt et al. 2006; Miller and Waller 2003). Those steps encompass:

1. Identifying areas of concern and interest to the participants about their company's contextual environment (similar to traditional PEST<sup>2</sup> approach).
2. Brainstorming for key uncertainties, in-depth reexamining of the environmental variables listed during previous step.
3. Clustering key uncertainties, grouping causally related uncertainties, capturing the (emergent) understanding of the linkages and relationships among them.
4. Prioritizing uncertainties, identify and focus subsequent thinking on two dominant critical uncertainties or variables which could have the biggest potential impact on the company. This is done in order to find the plausible polar extremes of possible future outcomes.
5. Developing scenarios, at the "limits of possibility" for the future rather than abstract theoretical "best" and "worst" scenario.
6. Articulating and fleshing out scenarios, developing in-depth "storyline" of each of the scenarios, describing the state of the environment at the horizon year.
7. Identifying structural insights and potential discontinuities in the contextual environment. By identifying the drivers of change participants of scenarios writing are able to develop strategic responses and actions to improve company's competitive position in the future.
8. System behavior, application of system modeling, that is diagrammatic representation of the variables and their causal interaction, helps to explain the unfolding logic of the scenario story over time.

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<sup>2</sup> PEST is a strategic tool for identifying company's contextual environment, where particular letters stand for types of environment factors: P – political, E – economic, S – social, T – technological.

Scenario planning is a useful tool to assess the risk, identify uncertainties in the contextual environment and their impact on company's operations, but in its nature it is a descriptive tool. A decision making process has to be supported by effectiveness, value creation ability or simply profit generation ability over time. Therefore creating financial plans on the basis of assumptions constructed in scenarios, company valuation on the basis of scenarios (Daszyńska-Żygadło 2008) or integrating them with real options analysis (Miller, Waller 2003; Mills, Weinstein, Favato 2006) is a valuable postulate.

Participants of process of writing scenarios are able to notice that this work is not only to discuss radical differences in foreseeing the future, but rather to determine the impact of changing environment on decisions within company (project), resulting from differences in the scope of R&D investment, M&A transactions or territorial expansion. Crucial phase of scenario writing is to translate description of environmental factors to assumptions influencing financial condition of company. Only then actual influence of future business conditions for growth and value creation opportunities can be estimated.

Table 1 prepared on the basis of work of Miller and Waller (2003) and own analysis presents strengths and weaknesses of scenario planning in the context of possible complementing by real options analysis in the perspective of risk management.

Table 1: Scenario planning

Strengths	Weaknesses
<b>Participative</b> – insights are drawn from many sources, in most cases its internal company task, rich details are being added to foreseen futures, it stimulates organizational learning.	<b>Potentially unwieldy</b> – without consistency and logical causality scenarios will be just imaginative speculations and science fiction.
<b>Rich in details</b> – reaches beyond the constraints of quantitative models and includes contingencies that are difficult to measure.	<b>Non-quantifiable</b> – scenarios are in their nature descriptive.
<b>Narrative</b> – develops a series of stories about plausible future states that take into account the dynamic interactions between stakeholders, organization and its role in creating the future.	<b>Biases</b> – there is always a room for considering dominant personality opinions or excluding individual ideas and replacing them by groupthinking, another problem could be perceiving current conditions as future possibilities.
<b>Broad scope</b> – multiple plausible scenarios are constructed to cover a range of “limits of possibility” of future outcomes and uncertainties, diverse perspectives are taken into account.	<b>Possible lack of consensus</b> – due to different perspectives and participants opinions there might be a problem with common conclusions and formulating shared strategy.
<b>System modeling</b> – by the means of system dynamics causal interactions are being analyzed.	
<b>Externally-Focused</b> – method that enables to determine long-term opportunities, uncertainties and risk factors in the contextual environment of the organization.	

Descriptive nature of scenario planning enables company to identify most important environmental contingencies and their effects on its performance, but in the next step managers have to create and decide upon approaches to deal with those future conditions of

running a business. They also have to decide, estimate when and what kind of investments in strategic flexibility create additional value for a firm. Real option theory can be a useful solution for that issue.

Miller and Waller (2003) and Mills, Weinstein and Favato (2006) postulate that using real options analysis that is preceded by scenarios writing can significantly improve investment decision making process.

#### **4. Real options**

Real options approach towards investment appraisal was created as an opposition to classical NPV, IRR methods that do not take into consideration value of active management. For example Copeland and Antikarov (2000) argue that traditional NPV systematically undervalues every investment opportunity because of the lack of incorporation of management flexibility. Real options are valuable tool because they give management the flexibility to acquire, divest or switch resources in the moment when such actions create additional value to the company.

The term of “real options” was created by Stewart Myers in his article from 1977, by drawing attention to similarities of assets of the company and future opportunities related to them to financial call options (Miller, Waller 2006, p. 97). A starting point for assessing valuation methods of real options were papers of Black and Scholes (1973) and Merton (1974). Followed by Cox, Ross and Rubinstein (1979) who presented valuation of real options based on binomial trees. Since that time there was a lot of research conducted and papers published in that field. In eighties, Japanese companies were pioneers in using real options in business practice. During the 1990s, finance researchers developed or adopted advanced techniques of real options pricing (differential equations, dynamic programming, Monte Carlo simulations). But a significant gap remains between those models and management practice. Managers benefit from frameworks and processes that organize their thinking about real options, but in general they have limited familiarity with existing pricing models, what is more their practical problems with real option pricing often violate the assumptions of these models. Basic real option valuation parameters such as the current value of the resource, volatility of this value over time, exercise price and duration are difficult to calculate or determine.

Additionally there is no market for real options trading, because most of real options are created inside the companies, therefore there are no observable prices that could be a referring point for managers.

Among mostly criticized assumptions of Black-Scholes valuation model is the one to find a traded replicating portfolio that is highly correlated with company’s investment project. A primary difficulty exists with the lack of substantiation, from either theoretical principles or empirical data, for that replicating portfolio argument. It is hard to find on a capital market a traded replicating portfolio of financial assets for a typical corporate investment in real assets. It is also hard to believe on principle that an individual corporate investment, such as developing a new biotechnological laboratory or other R&D project, would be highly correlated with a particular stock or collection of stocks (Borison 2005, p. 19). Brealey and Myers in their corporate finance textbook (2000) state that replicating portfolio argument cannot be used in real options analysis as an assumption that one can rely on. Also, only under the assumption that there exists clear similarity between financial option and an investment project, it can be assumed that value of the base instrument is random variable with a certain distribution, the volatility of real option can be estimated on the basis of Monte Carlo simulation (Mizerka, 2005, p. 103)

Closer to the actual needs and abilities to understand and analyze real options by managers seems to be the event tree framework. This approach consists of the unfolding alternative (usually binary) value outcomes at discrete points in time over the time horizon of a project. It is based on future cash flows and hurdle rate of a project similarly to NPV analysis. Binary value outcomes assume that managers can intervene by their decisions in order to add value to the project. Mapping on the decision tree the possible resource value paths, managers can determine the expected value of an option and plan the timing of key investment or divestment decisions.

The problem of real options pricing is very complex. Yet, there is no method that allows to estimate an objective value of such an option, even under certain assumptions. Anyhow most researchers are very optimistic about the future of that discipline and there is a great deal of agreement about the appeal of the underlying concepts. Copeland and Antikarov in the introduction to their monograph on real options (2000) argue that real options analysis will replace NPV within ten years because of its superior treatment of flexibility in order to achieve the value maximization goal of companies.

Nevertheless most important virtues of the concept are valuation of flexibility and quantitative approach. This combined with assumptions constructed on the basis of scenario planning can result in creating integrated and complete framework for risk assessment and management. In table 2, prepared on the basis of work of Miller and Waller (2003), there are strengths and weaknesses of real options analysis that in some fields complement scenario planning approach.

Table 2: Real option analysis

Strengths	Weaknesses
<b>Values flexibility</b> – emphasizes the contributors of flexibility and active management in creating the future.	<b>Difficult to value in practice</b> – many of the inputs to option valuation have no direct proxies outside a financial context; modifying models to fit a particular situation may be costly or impossible (difficulties in finding “twin” security or traded replicating portfolio)
<b>Quantitative rigor</b> – models provide parsimonious formulas for calculating real option values; option pricing emphasizes potential value, not just NPV	<b>Unrealistic assumption about managers and organizations</b> – managers lack experience and organizations lack systems to support real option analysis.
<b>Timing</b> – helps managers decide when entry and exit should happen.	<b>Evaluative not generative</b> – useful for evaluating projects, but less helpful for designing them
	<b>Isolates options</b> – neglects portfolio implications
	<b>No link to environment</b> – despite recognizing uncertainty, real option analysis does not reveal the environment factors affecting fluctuations in resource values.

## 5. Integrated risk management process

According to the list of strengths and weaknesses presented in tables 1 and 2 as well as analysis conducted in previous sections on scenario planning and real options it can be noticed that operational risk assessment and analysis could be significantly improved if those two tools are integrated. There is no evidence that those approaches were combined in

business practice, but Miller and Waller (2003) have proposed a framework of integrated risk management process that combines them. Mills, Weinstein and Favato (2006) have shown on two examples from pharmaceutical industry how, if implemented, this process could have reduced the risk of research and development investments. Main conclusions resulting from that analysis come to the point that including scenarios analysis and looking for certain factors perceived as “limits of possibility” and including them in financial analysis could have saved those companies from failed investments. Although what Mills, Weinstein and Favato (2006) have done wasn't actually a robust test of earlier proposed integrated risk management process. That was rather a case study analysis showing that real options analysis performed on the basis of creative assumptions about the future resulting from scenarios is more effective in estimating value of investment than real option analysis done on the basis of one basic scenario of the future.

The most important postulate, that hasn't been mentioned yet, by cited authors, is to create coherent visions of the future of a company in certain states of contextual environment and by measuring financial effectiveness properly evaluate the decisions that can be made now about the future or in the future. This is very challenging task, but when qualitative and quantitative approaches are combined and managers cooperate in order to obtain correct and useful in further decision process results it should be satisfactory and value creating exercise.

The framework of risk management from Miller and Waller (2003) is presented in order to substantiate the usefulness and importance of complementing scenario planning by modern financial tool in order to manage risk more effectively. Additionally it is modified and discussed in the light of inputs from previous sections and own author's research on integrating scenario planning into financial planning and company valuation process.

**Step one:** envision and articulate plausible state of the world via scenario planning process. Formulate strategies, summarizing various business-level risk exposures, aggregating them to form a corporate-level exposure profile.

**Step two:** identify exposures, considering the full set of contingencies together, grouped in three categories: (1) general environmental uncertainties, (2) industry uncertainties, (3) firm-specific uncertainties. Choose those that could have the most significant effects on business performance. Begin at the business level and then combine exposure assessments at the corporate level.

**Step three:** choose real option investments in order to manage risk by increasing or decreasing exposures. Real options analysis will allow to determine which exposures create additional value and which destroy it. Evaluating real options concurrently is better than sequentially, taking into account if these options are complementary or mutually exclusive. It is important to take corporate-wide perspective when assessing and managing risk. When assessing hedging requirements managers should consider net corporate exposures (some exposures may be offset between businesses of a company) in order to avoid excessive hedging or unsound hedging. Evaluate effects on corporate exposures.

**Step four:** Implementation by: monitoring key contingencies, building flexibility into the company, timing sunk commitments, reassessing exposures that change over time as company invests in flexibility or adjusts its strategy.

Detailed description and discussion on the process can be found in the work of Miller and Waller (2003). Its contribution to better use of real options and coherent risk management approach is unquestionable, but there exists one gap that needs to be filled in. Regardless the valuation method, future cash flows of an investment project or business unit are required to conduct the real options analysis. The proposed integrated process should be complemented by one additional step dedicated to constructing assumptions for cash flows estimation in each scenario of the future. It is indispensable to forge general, qualitative effects on business performance resulting from scenarios into quantitative assumptions referring to financial

parameters required for cash flows calculation. Depending on the level of detail requirements proper formulas should be used. One that is well acknowledged in corporate finance comes from the textbook of A. Rappaport on Creating Shareholder Value (1998, p.34), Free Cash Flows to the Firm are given as:

$$FCFF = \text{Cash inflow} - \text{Cash outflow} = [(\text{Sales in prior year})(1 + \text{Sales growth rate})(\text{Operating profit margin})(1 - \text{Cash income tax rate})] - (\text{Incremental fixed plus working capital investment})$$

It is important to decide how certain contingencies described in scenarios will influence the levels of: sales growth rates, operating profit margins, cash income tax rates, investment in fixed assets and investment in working capital in the whole period (starting from next year until the horizon year of scenario or end of real option investment). And it seems to be an indispensable minimum set of financial assumptions. Consecutively, according to chosen real options pricing method other parameters have to be determined.

In implementing a process that combines strategic and financial tools for risk management purposes it is essential to maintain balance between qualitative and quantitative details.

Although, authors of the analyzed process address that except for the understanding of how contingencies affect resources values over time, managers need to know which contingencies affect cash flows in order to monitor and manage those effects. In financial practice it does not work that straightforward. The contingencies rather influence the financial parameters such as revenues on sales, operating margin, tax rates or working capital investment to certain extend rather than cash flows in general.

Concluding it must be stated that the proposed integrated framework of risk management that incorporates scenario planning, strategy creating and real options analysis is valuable in terms of theoretical and practical aspects. The proposed adjustment adds financial insight into the strategic process, but it doesn't reduce the significance of it. In this process scenario planning tool is used to identify and categorize relevant uncertainties, and make managers able to explicitly identify key environmental contingencies affecting each business as well as make financial assumptions based on that. Real option decision making coordinates financial and strategic hedging responses to environmental uncertainties.

Further research would be required to test it on practical examples of investments or company valuation, as well as ask managers about possibilities of implementing it in their course of business.

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