Investigation of Regulatory Risk Implications through Cost-Benefit Analysis: A Water Supply Network Case in Poland

Roshan Taheri Bonab

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Prof. Dr. Elvan Yılmaz
Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Master of Science in Civil Engineering.

Assist. Prof. Dr. Mürüde Çelikağ
Chair, Department of Civil Engineering

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Master of Science in Civil Engineering.

Prof. Dr. Tahir Çelik
Supervisor

Examining Committee

1. Prof. Dr. Özgür Eren
2. Prof. Dr. Tahir Çelik
3. Ass. Prof. Dr. Alireza Rezaei

ABSTRACT

Regulatory risk is the interaction between regulation and uncertainty that results in change of financing cost of a firm or project. Given capital intensive nature of the infrastructure projects, any factor including regulatory risk that may affect the cost at which this capital is obtained, plays a very important role in successful implementation of infrastructure projects. To assess the role of regulatory risk in success or failure of infrastructure projects, a water supply project in Bydgoszcz Poland has been analyzed. The cost-benefit analysis involving the modeling of project, analysis of different scenarios and risk analysis have been performed in this study. Asst.

The financial and risk analysis of the project show that the regulatory risk which in this case is the adoption of a new tariff calculation method, can adversely affect the profitability and financial viability of project. However, such a risk can also decreases the unpredictability and riskiness of the project upon its materialization and it reduces the sensitivity of project outcome to different factors.

Keywords: Cost-Benefit analysis, Regulatory risk, Risk analysis, Sensitivity analysis

ÖZ

Bir firmanın veya projenin finansman maliyetlerinin değişimi ile sonuçlanan regülasyonu ve belirsizlik arasındaki etkileşim, yasal risk diye tanımlanır. Altyapı projelerinin yoğun sermayeye ihtyacı doğası göz önüne alındığında, bu sermayenin elde edildiği maliyeti etkileyebilecek yasal risk dahil olmak üzere herhangi bir faktör, altyapı projelerinin başarılı bir şekilde uygulanması için çok önemli bir rol oynar. Yasal riskin altyapı projelerinin başarılı veya başarısızlığındaki rolünü değerlendirmek için, Bydgoszcz Polonya su temini projesi analiz edilmiştir. Bu çalışmada proje modelleme, farklı senaryoları ve risk analizi içeren maliyet-fayda analizi gerçekleştirilmiştir.

Bydgoszcz yönteminin yeni bir tarife hesaplama sistemi benimsenmesini yasal risk sayarak, finansal ve risk analizine göre projenin karlılık ve mali sürdürülebilirliğini olumsuz etkileyecektir. Ancak böyle bir riskin gerçekleşmesi aynı zamanda projenin öngörülemezliğine, riskliliğini, ve sonuçlarının farklı faktörlerin değişime hassasiyetini azaltır.

Anahtar Kelimeler: fayda-maliyet analizi, yasal risk, risk analizi, duyarlılık analizi

I owe quit a lot to my grandmother who brought me up and my parents Hamid and Parivash for their support throughout all of my studies. I would like to dedicate this study to them as an indication of their significance in my life.

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LIST OF ABBREVIATIONS

ADB ………………………………….…………………… Asian Development Bank

ANOVA …………………………………………………..… Analysis of Variance

AD ……………………….…………………… Automated Differential Sensitivity

BOO ………………………………………………………….. Build Operate Own

BOT ………………………………………………………. Build Operate Transfer

CBA ………………………………………………………. Cost benefit analysis

COB ……………..……………………………………………. City of Bydgoszcz

DG regional policy …………………………….. Directorate General regional policy

DOE ……………………………………………...…… Design of Experiment

DSA ……………………………………...…… Differential Sensitivity Analysis

DSCR …………………………………………...….. Debt Service Coverage Ratio

EBRD ……………………...… European Bank of Reconstruction and Development

EU ……………………………………………...………………… European Union

EUI ………………………………………………...… Economist Intelligence Unit

FAST …………………………………….… Fourier Amplitude Sensitivity Test

IRR ………………………………………………….…….. Internal Rate of Return

LLCR ……………………………………………….. Loan Life Coverage Ratio

MWIK ………………………...…. Miejskie Wodociagi i Kanalizacja w Bydgoszczy

NPV ……………………………………………………...…….. Net Present Value

NRS …………………………………………..……. Nominal Range Sensitivity

OFWAT ……………………..…………………………… Office of Water Service

PCB ……………………………………………..…… Polish commercial Banks

PCC ………………………………………………. Pearson’s Correlation Coefficient

PLCR ………………………………...……………. Project Life Coverage Ratio

PLN …………………………………………………..…………. Polish Zloty

PMCC …………………………………….. Product Moment Correlation Coefficient

RTI ………………………………..…………… Research Triangle Institute

SA ……………………………………………………………….. Sensitivity analysis

SRCC ………………………………………. Spearman Rank Correlation Coefficient

USAID …………………..… United States Agency for International Development

WPWIK …………… Wojewódzkiego Przedsiębiorstwa Wodociągów i Kanalizacji w Bydgoszczy

ΔLOR …………………………………………..…. Difference in Log-Odds Ratio

Chapter 1

INTRODUCTION

1.1 Introduction

Regulatory risk is defined by Wright, Mason, & Miles (2003) as "factors that are under the regulator's control and the choice of which is regarded as uncertain by the regulated firm and investors". Some of other resources use an alternative approach and try to define the regulatory risk through its effects. For example Ergas, Hornby, Little, & Small, (2001)define regulatory risk as the interaction between regulation and uncertainty that result in change of financing cost of a firm or project.

Generally the capital necessary for investment in development projects including water and sanitation is provided through different sources. These sources include commercial loans, shares, bonds, government subsidies etc. In Most of these cases, the price at which the capital could be obtained depends on how profitable and risky the project appears. Capital market plays a formidable role in providing funds for water and sanitation industry. This role is very significant and comprises 52.2% of capital structure of the international water industry (OFWAT, 2002).

Because the capital cost is closely correlated to future vision of project and its profitability or riskiness, any factor that may change the future outcomes of the project have significant impacts on the available ways of financing which in turn determine its success. Hence any regulatory intervention or change that is capable of impacting the future of projects, directly affects the prices of available capital.

According to Rees (1998), regulatory risk is one of the main forms of risk that adversely affects the water and sanitation industry in addition to construction, political, commercial and financial risks, and in table 1 it is also claimed to be as the first or second greatest challenge for businesses by EUI (2005); Ernst & Young (2008); Ernst & Young (2009) (as cited in Strausz 2011).

Table 1: Top 5 Risks to business (Strausz, 2011)

Rank	EUI (2005)	Ernst & Young (2008)	Ernst & Young (2009)
1	Regulatory risk	Regulatory and compliance	Credit crunch
2	IT network risk	Global and financial shocks	Regulatory and compliance
3	Human capital risk	Aging consumers and workforce	Deepening recession
4	Reputational risk	Emerging markets	Radical greening
5	Market risk	Industry consolidation	Non-traditional entrants

Taking these into consideration, this research tries to find the effects of cost recovery method adoption as a type of regulatory risk on water supply projects. This research started with financial modeling of a water supply project in Bydgoszcz, Poland as a case study to discover the effects of regulatory risk on the project. In this case the regulatory risk is possibility of adopting a new method for tariff calculation.

The first step in this research was the development of a new financial model that addresses the shortcomings of the earlier model and also calculates the tariff through assessment of necessary revenue in addition to the method used in the earlier model, then the financial and risk analysis was carried out according to a comprehensive set of possible scenarios. However, the main focal point of this research remained the investigation of how such a change in regulation will affect the riskiness of the project rather than its profitability. In other words, we try to understand and estimate the effects of a regulatory risk by employing cost benefit analysis together with powerful sensitivity analysis methods and Monte Carlo simulation (Nemuth, 2008). Furthermore the volatility of project outcomes to the different parameters is studied and pertaining pattern of sensitivity to these parameters are assessed by calculation of rank correlation for each one of them.

1.2 Scope and Objectives of Research

The scope of this research covers the investigation of implication of regulatory risks using cost benefit analysis and to determine the financial viability and riskiness of the project after and before such a risk is materialized. This study searches for the answers to the question of how a change in the regulation may alter the sensitivity of investment outcomes to different parameters. Therefore, the major objectives of the research are as follow:

1. Determination of necessary revenue for inclusion of cost-recovery method as a regulatory risk in the new model.

2. Determining the effects of applying cost-recovery method on the financial viability of the project.

3. Determining the effects of applying cost-recovery method on the overall riskiness of the project.

4. Assessing the sensitivity trend of project out comes to different risk factors, corresponding to timing of imposition.

1.3 Framework of Study

1. Existing books, journals, websites and other publications regarding cost-recovery method and routine techniques applied for calculation of necessary revenue in Poland has been studied. Then based on standard methods, the necessary revenue for this project has been determined and the corresponding tariffs for each year were calculated.

2. The new model, capable of applying both new and earlier tariffs was developed and the financial analysis of the project was performed.

3. The risk analysis, through Monte Carlo Simulation, was executed based on different timings of imposition to assess the trend of riskiness of the project.

4. Through rank correlation method, the trends of sensitivity to each different risk factor were determined.

1.4 Achievements

By this study the effects of materialization of a regulatory risk has been quantified by determining the performance indicators of the project for both before and after the change in regulation via considering all possible scenarios in terms of imposition year. Both incremental and total effects of the project from equity holder and banker's point of view were assessed and finally the implications of this kind of risk are interpreted from equity holder's point of view.

In this research:

1. The necessary revenue for each year of the project has been determined and based on those values the corresponding annual tariffs was calculated.

2. The financial analysis of the project has been carried out based on cost-recovery method and the adverse effect of applying the cost-recovery method was revealed.

3. This study showed that the application of cost-recovery method reduces the uncertainty surrounding the outcomes of project.

4. The study also revealed the diminishing sensitivity of project outcomes to different factors as a result of adopting the cost-recovery method.

1.5 Overview of the Thesis

Chapter 1 is mainly concerned with the objectives of study its significance and achievements of the research.

Chapter 2 covers an extensive overview of the literature about the sensitivity analysis, risk appraisal and regulatory risk and a brief part regarding cost recovery method.

In chapter 3 a description of the project, the city of Bydgoszcz and existing situation of the water supply utility is provided.

In chapter 4 the methodology that has been applied in this research is quite extensively elaborated.

Chapter 5 includes the results of the study, discussion and related justifications for differences are provided.

In Chapter 6 the implication and interpretation of results were described thoroughly.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

This chapter consists of four main parts, in the first part regulatory risk is defined and explained. In the second part a brief history of sensitivity analysis is described and definitions from different fields of application have been given. The functions of sensitivity analysis and its different applications are explained. Through giving some examples of recommendations the importance of sensitivity analysis is revealed. Then some examples of sensitivity analysis classification methods are explained. Different methods of sensitivity analysis, their advantages and disadvantages are discussed. In the last part the regulatory risk, its definition, effects and aspects are discussed.

2.2 Regulatory Risk

Regulatory risk is defined in different ways depending on the context, some define it through its effects, sometimes it is defined through what it stands for or represents and in other literature it is defined based on scope and limits of mandate that authorized institutions have concerning amendment of existing regulation or development of new regulation.

Strausz (2011) describes the regulatory risk as reflection of uncertainty that surrounds new or amended regulation. Accorcing to Wright et al. (2003) regulatory risk is “factors that are under the regulator’s control and the choice of which is regarded as uncertain by the regulated firm and investors”. Ergas et al. (2001)

like other researchers who identify and explain the regulatory risk through its effect on capital cost, define it as an interaction between regulation and uncertainty that alters the cost of capital for firms. Wright et al. (2003) also define the regulatory risk in the same way. Given this variety of definition Kolbe, Tye, and Myers (1993, p. 33) claim that “there appears to be no generally accepted definition of regulatory risk” (as cited by Knieps & Weiß, 2007).

One classification of regulatory risk divides it into two major categories. One category is the triggering rule risk that concerns the possibility of enacting such a rule and the other category covers the configuration or lay out of such a regulation that is going to be imposed which is called setting rule risk (Knieps & Weiß, 2007).

An uncertainty in order to be considered a risk factor, in addition to being uncertain must also have a considerable effect on the final result. Regulatory risk meets the first requirement owing to its uncertainty which has two aspects. First aspect is the uncertainty regarding the possibility of occurrence and the other concerns the setting and details of new or altered regulation.

The second criterion to be met is being capable of inflicting considerable impact on the results. As it is implied by different definitions provided above, regulatory risk is always recognized and measured through its effect on cost of capital. The capital structure of international water and sanitation industry is very dependent, as much as 52% (OFWAT, 2002), on capital provided via market e.g. loans, shares and bonds.

Such dependence renders the success of water and sanitation projects very sensitive to cost at which their capital are provided.

Also other researches confirm the formidable role that regulatory risk has on the success of projects. According to Rees (1998), regulatory risk is one of the main forms of risk that adversely affect the water and sanitation industry in addition to construction, political, commercial and financial risks and also in table 1 it is claimed to be as the first or second greatest challenge for businesses by EUI (2005); Ernst & Young (2008); Ernst & Young (2009) (as cited in Strausz 2011).

2.3 Definition and History of Sensitivity Analysis

The early applications of sensitivity analysis goes back to 19th century as Smith, Szidarovszky, Karnavas, & Bahill, (2008) state:

"The earliest sensitivity analyses that we have found are the genetics studies on the pea reported by Gregor Mendel in 1865 and the statistics studies on the Irish hops crops by Gosset writing under the pseudonym Student around 1890."

This long history resulted in abundance of literature and this maturity lead to wide application of this method in many disciplines and fields. Since there are extensive literature, the available definitions of it also varies depending on the context in which the definition is provided.

Saltelli, Tarantola, Campolongo, & Ratto, (2004) define sensitivity analysis as a study through which the fluctuations in model output are apportioned to different variation sources, qualitatively or quantitatively.

As Environmental Protection Agency, Office of Solid Waste and Emergency Response (1999) defines, “Sensitivity analysis, as it is applied to risk assessment, is any systematic, common sense technique used to understand how risk estimates and, in particular, risk-based decisions are dependent on variability and uncertainty in the factors contributing to risk.”

Trejo & Reinschmidt in their article concerning material selection for bridges have defined sensitivity analysis as procedure for determining change rate of output pertaining to fluctuations of input parameter (Trejo & Reinschmidt 2007).

Definition of sensitivity analysis according to European Commission guideline is an analytical technique for systematic test of project's earning capability if situation differs from the estimations adopted planning process (Eropean Commission, DG Regional Policy, 2006).

Although differences in the definitions of aforementioned resources is apparent, it is not due to dissimilar nature of sensitivity analysis employed but rather difference are dependent upon the context in which the technique is employed that in turn is a result of diverse role it may play in the fields of application. In this research adopts Environmental Protection Agency, Office of Solid Waste and Emergency Response (1999) definition of Sensitivity Analysis.

Usually each discipline and field draws upon the same subset of functions of sensitivity analysis, for example in Cost-Benefit Analysis (CBA), sensitivity analysis is used as tool for significant parameter discovery whereas in an environmental modeling process the validation capability of sensitivity analysis is much more valuable.

2.4 Functions and Importance

Sensitivity analysis has its own merits and can play a major role in decision making process. Frey & Patil (2002) point to significant risk factor identification and mitigation method prioritization capabilities of sensitivity analysis and they also point to other researches regarding the aplication and merits of this method. According to Baker , Ponniah, & Smith, (1999) one of major quantitative methods employed for risk management inside the UK is sensitivity analysis. Frey & Patil (2002) indicate other researches findings regarding sensitivity analysis like provision of a basis for climate change risk mitigation measure planning, additional data or research prioritization tool, verifying and validating tool for models, and also result verification method. According to Smith et al. (2008) the sensitivity anlysis should be employed when a model is created, a system is designed, a decision is going to be made, looking for cost drivers or risk analysis is being carried out.

Smith et al. (2008) point to many functions of sensitivity analysis which are model validation, detection of unrealistic model behavior, discovering the significant and influential assumptions, simplifying models, decision support for data collection, determining the level of resolution needed for data gathered, resource allocation.

The aforementioned merits of sensitivity analysis have led to recommendation of this technique in many CBA and economic analysis guidelines of many international institutions. The importance of sensitivity analysis is recognized in following institutions:

- Asian Development Bank (ADB) in its handbook for economic analysis of water supply projects announces sensitivity analysis as one of the main steps of economic analysis (Asian Develpment Bank, Economics and Development Resource Center, 1990).

- European Commission in its guideline document for CBA instructs that a project assessment document must have a risk analysis part of which sensitivity analysis is the first step (Eropean Commission, DG Regional Policy, 2006).

- Asian Development Bank in another publication for CBA for all projects states that sensitivity analysis should be applied to all of programs and their constituting projects (Asian Develpment Bank, Economics and Development Resource Center, 1997).

- Vulnerability test of options to upcoming unavoidable uncertainties by sensitivity analysis is considered as fundamental to appraisal (UK's economics & finance ministry, 2012).

There are many fields in which this method is used and Smith et al. (2008) names a few of them as Analysis of feedback amplifiers and networks, social model validation, psychological and engineering models, disease treatment, expert systems, numerical computations, etc. Frey & Patil (2002) indicate engineering systems, economics, physics and social sciences as disciplines that utilized sensitivity analysis.

2.5 Procedure

Due to complexity in most of models, an analytical approach is not possible and the model is usually supposed as a black box with no regards to internal mechanism. Such supposition necessitates a numerical approach to the problem like sample-based sensitivity analysis.

Sample-based sensitivity analysis includes a simulation phase that is preceded by sampling phase. The appropriate method for latter i.e. sampling of input space is determined through design of experiment via different methods like Latin Hypercube sampling. Not limiting the Design of Experiment (DOE) to sampling method, there are many other strategies introduced in DOE for addressing different problems like polynomial curve fitting, input interaction analysis, input space exploration.

The steps of sensitivity analysis are as follows:

- Defining the question to be answered to determine the appropriate sampling and analysis method.

- Assignment of probability distribution for input factors

- Performing the sampling

- Calculation of outputs for set of inputs via simulation

- Analysis of output through sensitivity analysis method determined to be appropriate in the first step.

2.6 Methods and Classifications

Methods of sensitivity analysis are classified depending on their capability or methodology (Saltelli, Chan, & Scott, Sensitivity Analysis, 2000). One of these methodological classifications is suggested by Frey & Patil (2002) as mathematical, statistical and graphical methods. They also introduce classification as an aid to verifying the applicability of method to the intended subject of study.

In mathematical methods the effect of range of inputs on output is the focus point of analysis. Ignorance of output variance is claimed as a shortcoming of these methods by Morgan & Henrion (1992). Mathematical methods are used for screening (Brun, Reichert, & Künsch, 2001), model validation or verification (Wotawa, Stohl, & Kromp-Kolb, 1997) and identification of further data acquisition or research (Ariens, Van Mechelen, Bongers, Bouter, & Van Der Wal, 2000). Difference of Log-odd Ratio (ΔLOR), nominal range analysis, break-even analysis and differential sensitivity analysis are the examples of mathematical methods.

Statistical methods comprise assignment of probability distributions to input variables and assessment of their respective effect on output through simulation (Andersson, Åberg, & Jacobsson, 2000). Monte Carlo simulation, discrete event simulation and Latin Hypercube sampling methods are some of the simulation techniques employed in statistical methods. The results of the simulation can be evaluated through alternative methods like Sample and Rank Correlation Coefficients, Regression Analysis, Analysis of Variance (ANOVA), Rank Regression, Fourier Amplitude Sensitivity Test (FAST) etc.

Graphical methods generally play a complementary role along mathematical and statistical as an interpretation and communication media. These methods are depictions of sensitivity and try to offer an indication of how sensitive the outputs are to swings of different inputs (Frey, Mokhtari, & Danish, 2012).

2.6.1 Graphical Methods

These methods are the simplest method of sensitivity analysis (Saltelli et al. 2000). Through visualization, graphical methods reveal the association, correlation, linear or non-linear relation between inputs and outputs. The advantages of this method are being global measure, being capable of identifying complex dependencies and ease of understanding. There are different graphical methods like radar graphs, scatter plots and tornado charts.

Scatter plots are one of the most popular kinds of graphical method and allow the user to spot any association or correlation of changes in the input space. An example of different scatter plots is given in Figure 1:

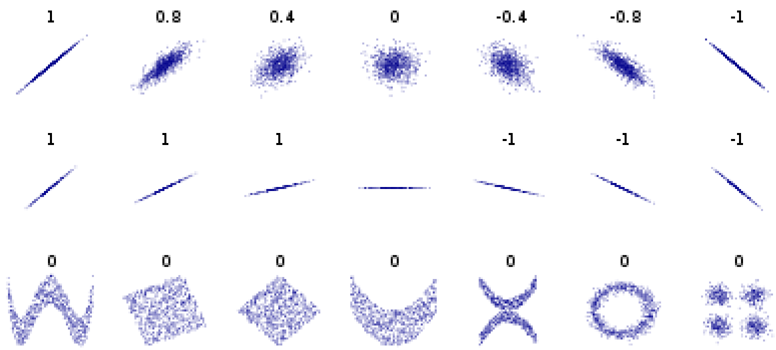

Figure 1: Scatter Plot

(Source: http://www.economicenquiry.com/archives/98)

The first two row of this picture shows a linear association between the input and output which is called correlation and the associated numbers shows the intensity of correlation between them. In other words the higher the value the more sensitive the factor. The third row shows non-linear forms of association.

The other graphical method is radar graph that an example is given in Figure 2:

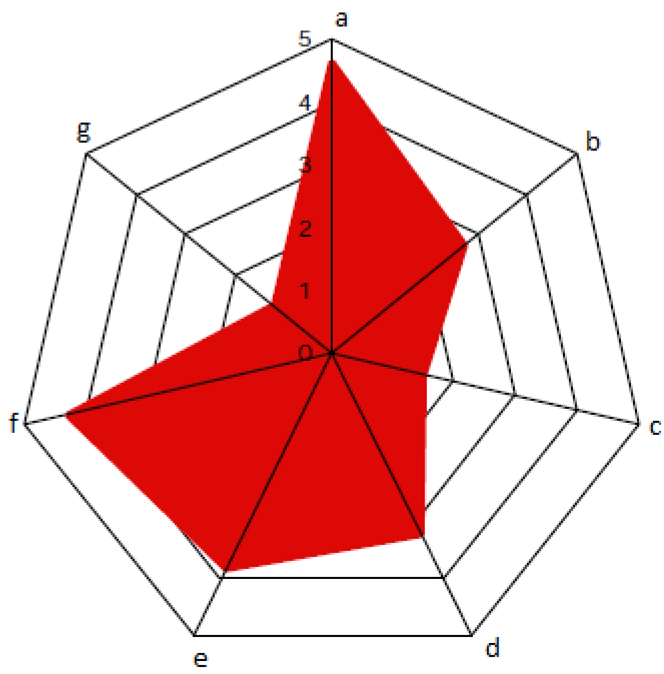

Figure 2: Radar Chart

(Source: http://web2.concordia.ca)

In this figure each radius stands for a factor influencing the result and the sensitivity of each factor is shown by colored lines. For example in this Figure 2 factor a is the most influential and factor g is the least sensitive one.

2.6.2 Nominal Range Sensitivity (NRS)

Also known as One-at-a-time analysis the NRS involves evaluation of outputs for one at a time changes in the input variables throughout their possible range (Frey & Patil, 2002). In this method the sensitivity is represented either as a number or as a percentage of base case output.

Equation 1: Range sensitivity

In this formula the X_{ju} is the highest value of input X_j and X_{jl} is the least possible value of X_j given that the range of this particular variable is between $[X_{jl}, X_{ju}]$. Hence, by keeping other inputs constant and calculating the difference between value of output of highest and lowest X_j is calculated. Then this difference is divided by the base-case value of output to calculate the extent of influence this variable has on the output.

The results of this method are very useful when applied to linear models. Simplicity of application and interpretation are the advantages of this method but dependence of validity of results on the structure of model (linear or non-linear) and inability to consider the correlation between inputs are shortcomings of this method.

2.6.3 Difference in Log-odd Ratio (ΔLOR)

Principally ΔLOR uses the same methodology as NRS. However, in this method instead of values of output, its probability of occurring is used and for the representation of sensitivity the ratio between obtaining and not obtaining a specific value for output is used.

The ratio between probabilities of occurrence of an event to probability of not occurring of the same event is the odds ratio of that event. The log-odds ratio or logit is the simply the logarithm of odds ratio. The formula for logit is as follows:

Equation 2: Logit

The ΔLOR or the difference in log-odds ratio is:

Equation 3: ΔLOR

Through this formula the change in the odds ratio of obtaining a specific value with and without changing the input values is calculated. A positive ΔLOR means the increased probability of event due to changing the input and vice versa. The higher ΔLOR values show the significance of the manipulated input parameter.

Given its methodological analogy to NRS, this method suffer from the same shortcoming of NRS method and in addition to them the outstanding advantage of ΔLOR limits its applicability to other situations, i.e. this method can only applied in those cases which output values are probabilities.

2.6.4 Break-Even Analysis

Break-even, a term obtained from economics, refers to a point, threshold or value that surpassing or falling below that cutoff point brings about the indifference of supplier regarding the producing or not producing a good. In the context of sensitivity analysis, this method involves the search for those values of input or thresholds that after those points, the previously taken decisions need to be change. According to Frey & Patil (2002) the combination of values of inputs for which a decision maker becomes indiffernt to the different options is the break-even point.

If the range of plausible values of the input spans a break-even point then this input should be considered as an important factor, because if the input reaches or surpasses this point the decisions made at analysis phase become in appropriate and need to be changed. For example, after determining the break-even points of different inputs a risk manager should decide on whether the input value is likely to reside above or below this point. If the risk manager fails to determine the inputs likely position with respect to break-even point and the range of uncertainty encompasses the break-even point, then the decision maker should spent more time, effort and resources to reduce the uncertainty surrounding the input factor.

The high number of different scenarios that need to be evaluated and the inability to assign a rank to inputs is another shortcoming of this method (Frey & Patil, 2002).

2.6.5 Differential Sensitivity Analysis (DSA)

Through calculation of partial derivatives, this method provides an insight to behavior of model throughout a small interval surrounding a specific value. In this method the local sensitivity is calculated as finite difference index which is equal to respective change in the output due to small perturbation equal to Δx in the input.

According to Frey & Patil (2002) the formula for sensitivity index is

Equation 4: Differential Sensitivity Analysis

In automated form of this method which called Automated Differential Sensitivity (AD), the partial derivatives of the model with respect to some points in the parameter space are considered as the measure of sensitivity. The advantage of DSA is the conceptual simplicity and its disadvantage is locality of analysis due to considering merely the close interval around point estimate. However this shortcoming has been eased by AD.

2.6.6 Product Moment Correlation Coefficient (PMCC)

If an association between two variables exists, the value of one gives an indication of likely value of other variable. If such association could be considered as a linear one then it is called correlation and the strength of this association can be measured by correlation coefficient. The formula for PMCC which is also called Pearson's Correlation Coefficient (PCC) is:

Equation 5: Pearson's Correlation Coefficient where σ_{xy} is the covariance between variables and denominator is the product of variances of X and Y respectively. The range of this indicator is between -1 and +1. The high absolute value of this indicator shows a strong correlation between output and input but input variables with correlation of zero or close to it lack any considerable association with putout (Frey et al. 2012). Simplicity of application and availability of software are the advantages of this method. According to Mokhtari & Frey (2005) correlation cannot prove causality hence, correlation between to variables can be result of a strong correlation between those two and a third underlying variable. The other shortcoming of PMCC is its limitation of validity only for linear association and in the case of non-linear association the PMCC method become invalid.

2.6.7 Regression Analysis

According to Mokhtari & Frey (2005) different versions of regression analysis like standardized least square method are applicable for the purpose of regression analysis. This method involves fitting of a curve to the set of input and respective output data then the resulting parameters of the curve's function are the measures of sensitivity to different inputs. This function has usually the following form:

Equation 6: Regression Analysis

Where b_i correspond to coefficient of regression and the ε_j are error due to approximation. In standardized method, the outputs and inputs standardized to get rid of the scale effects.

In some cases instead of input and output data their corresponding ranks are used. As stated by Neter *et al.*, 1996 (as cited in Mokhtari & Frey 2005), the standardization is a process whose objective is to solve scale and dimension problem of input and output data. This process involves subtraction of mean from the data and dividing them by standard deviation.

Advantage of this method is its ability to take into account the simultaneous effect of inputs on the output. The dependency of results on the functional form selected for regression analysis is a drawback of this method. According to Neter *et al.*, 1996 (as cited in Mokhtari & Frey 2005) regression analysis might produce vounter-intuitive or statistically insignificant results.

2.6.8 Analysis of Variance (ANOVA)

According to Frey et al. 2012 ANOVA is used for proving the existance of an statistically significant association between output and inputs. The existence of a statistically significant difference between input means should be proved by an F-test to show the considerable role of variances of inputs in the variations of the output. The relative value of F-test for each input is the measure of its importance in sensitivity analysis.

The applicability to both continuous and discrete numbers is one of advantages of this method. This method also allows for evaluation of main and interaction effects. One of disadvantages of this method is its computational intensity that makes the use of primary screenings compulsory.

2.6.9 Spearman Rank Correlation Coefficient (SRCC)

If the value of one variable offers an indication about the possible value of another variable, there is an association between those two variables and also linear associations is called correlations. One disadvantage of PMCC is its inapplicability to non-linear association. According to Helton, Johnson, Sallaberry, & Storlie, 2006 in order to overcome this problem, one method is to use the rank of data rather than values. By doing so, the non-linear relations could be transformed to linear one. When such a transformation is carried out, the PMCC cannot be applied anymore and instead the SRCC, also called rank correlation coefficient is used. Another reason of inapplicability of PMCC is due to the assumption of normal distribution of the population. Whereas, the PMCC assumes a normal distribution for bivariate data, the SRCC does not such a limitation. SRCC is member of wider testing method division that is called “distribution free” tests.

SRCC is non-parametric test and the aim of SRCC is to measure the monotonic association between two variables. The advantages of this method are its independence from the linearity and normality assumptions, the ease of application and availability of relevant software. This method like its linear alternative, PMCC, suffers from the same shortcoming which is the assumption of correlation as an implication of causality.

Chapter 3

PROJECT DESCRIPTION

3.1 Introduction

In this chapter the history and context of the case study project in which the investment were carried out is explained. Then the justification for such an investment and relevant assumptions and date are described.

3.2 Project Description

From 1975 till 1991 WPWIK (Wojewódzkiego Przedsiębiorstwa Wodociągów i Kanalizacji w Bydgoszczy) was responsible for supply of water in Bydgoszcz but after Local Self Government Act of March 1990 WPWIK was liquidated and MWIK (Miejskie Wodociagi i Kanalizacja w Bydgoszczy) has been in charge of this service since then. This company has limited liability structure and the municipality of Bydgoszcz is its only shareholder. The company operates and maintains 607 Km of water distribution network and 884 km of sewerage system only in the city of Bydgoszcz.

The water supply network of Bydgoszcz was preforming comparable to the UK practice (having low levels of water loss) and it was utilizing a technology that was considered suitable in 1999 but, lack of capacity to meet the peak demand and analytical data regarding quality of water were the deficiencies of the system. The insufficiency of pressure, due to incomplete mains and pumping during peak demand periods, exacerbate water quality problem due to leaks from outside of the system into the pipes.

The cause of the pressure problems was the scale build up due to incomplete treatment especially in the at Las Gdanski plant.

Hence, this project consists of three main parts to remedy aforementioned problems:

- Development and replacement of water supply mains, secondary and tertiary pipes

- Expansion of network

- Improvement of water treatment plants

The estimated total cost is around $191 million. Network expansion and treatment plant improvement being the two main capital intensive parts who account for 32.6% and 35.2% of whole investment respectively.

Given the financially non-profitable nature of water supply projects there are few options to make these projects appealing to private sector. Increasing the tariffs and government subsidies and grants are two options available. However, constraints like affordability and limited resources of governments have to be taken into account in the decision making process. In this case the European Commission was willing to provide for up to 70% of investment cost and the balance of investment were going to be covered by loans form European Bank of Reconstruction and Development

(EBRD), Polish commercial banks (PCB) and equity investment by City of Bydgoszcz (COB).

3.3 Data and Assumptions of the Case Study

The assumptions regarding the present and future circumstances of project performance, technology, demand and supply are as follows:

- Project appraisal period: 12 years
- Operating capacity of whole water supply system: 44.2 million m^3/year
- Increase in operating capacity: 3% p.a.
- Economic life of fixed assets:

  Machinery and pipes: 20 years

  Miscellaneous fixed assets: 10 years
- Tax-purpose life of fixed assets: 4 years
- Increase of industrial consumption: 5% p.a.
- Decrease of per capita domestic consumption: -3.5% p.a.
- Increase in domestic connection rate: 1.6% p.a.

- Labor is divided into worker and supervisor

- Increase in the wage rate for both categories: 2% p.a.

- The EBRD loan interest rate : LIBOR+1.5% = 7.5%

- The Polish Commercial Banks loans interest rate: WIBOR+3% = 16.31%

Table 3 summarizes the cost of mains, distribution lines, treatment plant and replacements. In the local portion column the amount of cost for each item that is provided by the local sources are given and in the foreign portion column, the amount of foreign financing is given in PLN. In the last column in addition to total cost of each item, their pertaining share of total cost is also shown.

In the Table 3 the last row shows how much of the total investment is provided through local and international sources.

The cost structure of the whole project is given in Table 3:

Table 2: Cost Structure of Project (in million PLN) (1US$ = 3.9 PLN)

Item	**Local portion**	**Foreign portion**	**Total**
Mains	108.70	134.30	243.00 (32.6%)
District Distribution Line	84.95	74.25	159.20 (21.4%)
Water Treatment Plant	164.50	97.10	261.60 (35.2%)
Replacement of Existing Lines	44.50	36.20	80.70 (10.8%)
Total	**402.65 (54.1%)**	**341.85 (45.9%)**	**744.50 (100%)**

The planned financial structure of the investment is as Table 4:

Table 3: financing of the project (in million PLN) (1US$ = 3.9 PLN)

Investment	*EBRD A Loan*	*EBRD B Loan*	*PCB A Loan*	*PCB B Loan*	*COB*	*EC*	*TOTAL*
Domestic	-	-	109.83	91.50	40.27	161.06	402.66
Foreign	152.65	189.20	-	-	-	-	341.85
TOTAL	**152.65**	**189.20**	**109.83**	**91.50**	**40.27**	**161.06**	**744.51**

Table 4 shows the amount of loans, grants and budget that is supplied by different parties involved in project. The first row of the Table 4 shows that the Polish Commercial Banks (PCB), City of Bydgoszcz (COB) and European Commission (EC) are contributing to project and supplying the financial resources in domestic currency. The second row show how the foreign portion of the investment is financed by European Bank of Reconstruction and Development (EBRD)

3.4 Model Description

In this section different parts of the project model will be described and underlying principals behind the calculation will be elaborated thoroughly.

For explaining different parts of the model, each worksheet and included subparts will be described. Then, in order to give a rough sense of what is underlying those numbers, a brief explanation of formula or methods of calculation will be presented.

3.4.1 Inputs

This worksheet has some particular attributes that other parts of the spreadsheet do not have it. This worksheet is the only sheet that numbers and values are directly entered to the pertinent cells and in all other work sheets any value is either referenced to these cells or calculated from these values. One reason behind this practice is that other programs like Crystal Ball necessitate it. In order to avoid spending extra time and effort and also evading mistakes, adhering to this practice is necessary and it grantees efficiency consistency of the model. In this work sheet it is also better to avoid including those cells that their value is calculated from other cells. Some information regarding the formatting of the model is also included in this work sheet that in the case of this specific model the colors used for different cell are described.

This worksheet contains many information, prediction, and assumptions regarding the current and future factors and circumstances. These information are divided into subsections that are as follows: general in information contains project start and interest rates are provided in macroeconomic subsections; construction and cost overrun level are in the construction subsection; operation subsection encompasses data regarding current tariffs in 1999 and projection of those tariff in the future, value of those factors that determine the amount of working capital, operating cost and demand components; investment schedule of the project in nominal and real terms and in different denominations (domestic/foreign), funding sources and the debt financing conditions are presented in funding subsection; Discount rates are summarized under the same subsection heading and other subsections include data concerning tax rates and different depreciation rates.

3.4.2 Timing

In this worksheet (see Figure 3) the project calendar is developed that in addition to dates also includes two switch-like rows that are used for separation of operating years and construction period and also used for automatic start and cessation of relevant activities in the spread sheet. This project calendar is embedded in all other work sheets except inputs.

	C	D	I	J	K	L
4	Appraisal Method : Incremental			1-Jan-99	1-Jan-00	1-Jan-01
5			31-Dec-98	31-Dec-99	31-Dec-00	31-Dec-01
6			Project Year	Project Year 0	Project Year 1	Project Year 2
7	Construction		12	1	1	1
8	Operation		11	-	1	1
10	**Inflation, Exchange Rate and Price Indices**					
12	**Domestic inflation**	% p.a.		6.88%	6.88%	6.88%
13	Domestic Price Index	Num#		1.00	1.07	1.14
15	**foreign Inflation (US)**	% p.a.		2.50%	2.50%	2.50%
16	Foreign Price Index	Num#		1.00	1.03	1.05
18	**Relative Price Index**	Num#		1.00	1.04	1.09
20	**Exchange Rate**					
22	Real Exchange Rate	PLN/USD		3.90	3.9	3.9
23	Nominal Exchange Rate	PLN/USD		3.90	4.07	4.24

Figure 3: Timing worksheet

Foreign and domestic price indices are two parameters that are calculated according to well-known principals of engineering economy and assumptions of inputs work sheet. They are calculated according to Equation 7

Equation 7: Price Index

Where and (also called I_t and I_{t-1}) are the two successive year's price index. The other parameters in this sheet are relative inflation index and nominal exchange rate that were calculated according to Equation 8 and 9 respectively

Equation 8: Relative Price Index

Equation 9: Nominal Exhange Rate

Relative price index is usually used for calculation of nominal exchange rate which or for obtaining real exchange rate from nominal one. It worth noting that real price, interest or exchange rate is values that do not contain any inflation effect. Real prices are obtained via dividing the nominal prices (affected by inflation) by price index. The calculation of real prices makes the addition or subtraction of different years spending or incomes in the base year, possible.

3.4.3 Construction (Const.)

This worksheet usually include investment schedule of construction in terms of both timing and amount. The schedules show the amount of planned investment from domestic and foreign investor's side in Dollar and Zloty denominations and also in real and nominal terms. As it is shown in Figure 4 the pertaining components of the project is also calcified in these tables.

Foreign Constructioin Expenditure				
1. Mains	Million PLN	134.30	4.00	10.00
2. District distribution lines	Million PLN	74.25	1.00	0.70
3. Water treatment Plants	Million PLN	97.10	21.90	5.40
4. Replacement of existing lines	Million PLN	36.20	0.00	1.30
Total	Million PLN	341.85		
Domestic Construction Expenditure				
1. Mains	Million PLN	108.70	4.00	4.20
2. District distribution lines	Million PLN	84.95	0.40	0.70
3. Water treatment Plants	Million PLN	164.50	30.00	25.30
4. Replacement of existing lines	Million PLN	44.50	0.00	3.90
Total	Million PLN	402.65		

Figure 4: Investment Schedule sample

In this worksheet also the financial resources planned to be obtained in specific dates are included in this work sheet as shown in Figure 5 to control for any cash shortfall throughout construction phase.

Sources				
Polish Commercial Bank Loan A	Million PLN	(131.59)	(17.20)	(18.22)
Remaining Balance	Million PLN	889.77	44.10	36.37
Polish Commercial Bank Loan B	Million PLN	(158.92)	-	-
Remaining Balance	Million PLN	730.86	44.10	36.37
EBRD Loan A	Million PLN	(169.55)	(26.90)	(18.14)
Remaining Balance	Million PLN	561.31	17.20	18.22
EBRD Loan B	Million PLN	(270.80)	-	-
Remaining Balance	Million PLN	290.51	17.20	18.22
EC/Phare	Million PLN	(232.40)	(13.76)	(14.58)
Remaining Balance	Million PLN	58.10	3.44	3.64
City of Bydgoszcz	Million PLN	(58.10)	(3.44)	(3.64)
Remaining Balance	Million PLN	-	-	-
Total		1,021.36	61.30	54.59

Figure 5: including sources of capital in construction phase

3.4.3 Funding (Fund.)

In this work sheet all relevant factors like capital structure, funding method, acquisition timing and sequence of loans are summarized for each loan. Then a table containing the information regarding loan tenor, its grace period, the years in which repayment and interest rate applicable to the loan is developed. Subsequently, according to agreed-upon repayment methods the a debt account for each loan is made as in figure 6 that encompasses the interest accrued, principal and interest paid and loan disbursements.

Appraisal Method : Incremental					1-Jan-99	1-Jan-00	1-Jan-01	1-Jan-02
				31-Dec-98	31-Dec-99	31-Dec-00	31-Dec-01	31-Dec-02
				Project Year	Project Year 0	Project Year 1	Project Year 2	Project Year 3
Construction				12	1	1	1	1
Operation				11	-	1	1	1
Polish Commercial Bank Loan A (Nominal PLN)								
Loan Tenor	[1,0]	1-Jan-99	31-Dec-05					
Grace Period	[1,0]	1-Jan-99	31-Dec-00				-	-
Repayment	[1,0]			5.00	-	-		
Cost Coverage Year	[1,0]							
Remaining Periods	Num#				-	-	5	4
Interest								
Constant Rate	% p.a.				3.0%	3.0%	3.0%	3.0%
WIBOR	% p.a.				13.3%	13.3%	13.3%	13.3%
Applied Rate	% p.a.				16.3%	16.3%	16.3%	16.3%
Debt Account								
Balance B/f	Million PLN				-	127.74	150.00	120.00
Loan Received	Million PLN				109.8			
Interesst Accrued	Million PLN				17.91	22.27	27.95	23.90
Principal paid	Million PLN				-	-	30.00	30.00
Interert paid	Million PLN				-	-	27.95	23.90
Total loan repayment	Million PLN				-	-	57.95	53.90
Balance C/f	Million PLN				127.74	150.00	120.00	90.00

Figure 6: Sample of Debt Account Table

The equity expenses and grant tables are the other tables that are calculated in this work sheet. Finally, as a summary, total of all principal paid, interests accrued, etc. is calculated (see Figure 7).

Interest accrued					
Polish Commercial Bank Loan A	Million PLN	17.91	22.27	27.95	23.90
Polish Commercial Bank Loan B	Million PLN	-	-	-	-
EBRD Loan A	Million PLN	11.45	12.83	14.39	13.50
EBRD Loan B	Million PLN	-	-	-	-
Total	Million PLN	29.36	35.10	42.33	37.40
Interest paid					
Polish Commercial Bank Loan A	Million PLN	-	-	27.95	23.90
Polish Commercial Bank Loan B	Million PLN	-	-	-	-
EBRD Loan A	Million PLN	-	-	14.39	13.50
EBRD Loan B	Million PLN	-	-	-	-
Total	Million PLN	-	-	42.33	37.40
Principal paid					
Polish Commercial Bank Loan A	Million PLN	-	-	30.00	30.00
Polish Commercial Bank Loan B	Million PLN	-	-	-	-
EBRD Loan A	Million PLN	-	-	19.18	20.00
EBRD Loan B	Million PLN	-	-	-	-
		-	-	49.18	50.00

Figure 7: Loan Summary Table

3.4.4 Operations (Ops.)

In this worksheet the demand, tariff, operating costs, sales and working capital tables are calculated. In demand subsection, the future total demand for the water is calculated for domestic, industry, commercial and remaining customers. In this part also the leakage is accounted for as in Figure 8.

Total case Demand Forcast					
Total Population	Num#	383600	385518	387446	389383
Total Population Connected to Water Supply	Num#	364420	370880	376814	382843
MWiK Incremental treated water production capacity cu. m./day	cu m/day	121093	120862	120577	120365
Per capita consumption liters/person*day	Liters/per/day	205	198	190	183
Domestic consumption cu m/day	cu m/day	74779	73289	71706	70158
Industry consumption cu/day	cu m/day	4695	4930	5176	5435
Remainder consumption cu/day	cu m/day	6223	6403	6589	6780
Commercial consumption cu/day	cu m/day	21784	22220	22664	23117
Total metered demand cu/day	cu m/day	107481	106842	106136	105491
Leakage in cu/day	cu m/day	13612	14020	14441	14874
Total Connections	cu m/day	123742	125722	127733	129777

Figure 8: Total Demand Forecast Table

The incremental demand that is only attributable to the new investment in also calculated with the same details as presented in Figure 9

Incremental case Demand Forcast		Base Line			
Total Population	Num#	383600	385518	387446	389383
Total Population Connected to Water Supply	Num#	364420	5841	5934	6029
MWiK Incremental treated water production capacity cu. m./day	cu m/day	121093	2413	2426	2441
Per capita consumption liters/person*day	Liters/per/day	205	198	190	183
Incremental Domestic consumption cu m/day	cu m/day	74779	1154	1129	1105
Incremental Industry consumption cu/day	cu m/day	4695	235	246	259
Incremental Remainder consumption cu/day	cu m/day	6223	180	186	191
Incremental Commercial consumption cu/day	cu m/day	21784	436	444	453
Incremental Total metered demand cu/day	cu m/day	107481	2005	2006	2008
Incremental Leakage in cu/day	cu m/day	13612	408	421	433
Incremental Connections total	cu m/day	123742	1980	2012	2044

Figure 9: Incremental Demand Forecasting

In tariff calculation tables, two methods are used for calculation of tariffs. One is through forecasted tariff increases and the other via cost recovery method based on necessary revenue (see Figures 10 and 11).

1999 Tariff Scenario					
Applicable period	num	1	1	0	0
Domestic tariff adjustment rate	%	50%	50%	40%	30%
Industrial tariff adjustment rate	%	10%	20%	10%	10%
Tariff adjustment rate of other uses	%	50%	40%	30%	20%
Real Water Tariff					
Domestic	PLN/cu m	3.0	4.50	6.75	9.45
Industrial	PLN/cu m	6.6	7.26	8.71	9.58
Others	PLN/cu m	3.3	4.95	6.93	9.01
Nominal water Tariff					
Domestic	PLN/cu m	3.00	4.81	7.71	11.54
Industrial	PLN/cu m	6.60	7.76	9.95	11.70
Others	PLN/cu m	3.30	5.29	7.92	11.00

Figure 10: Tariff Calculation Through Forecasted Change Rates

It worth noting that for calculation of tariff based on cost recovery method, it is needed to determine the necessary revenue before tariff.

new method					
Applicable periods		0	0	1	1
Real Water Tariff					
Domestic	PLN/cu m	3.0	0.12	2.78	2.43
Industrial	PLN/cu m	6.6	0.24	5.31	4.34
Others	PLN/cu m	3.3	0.13	2.82	2.37
Nominal water Tariff					
Domestic	PLN/cu m	3.00	0.13	3.17	2.97
Industrial	PLN/cu m	6.60	0.26	6.07	5.30
Others	PLN/cu m	3.30	0.13	3.22	2.89

Figure 11: Tariff Calculation Based On Cost Recovery Method

The next part concerns the operating costs of the project. In this part the total and incremental operating costs of the project is determined as in Figure 12.

DIRECT INPUTS						
Imported inputs (incl Import duty and VAT in millions of Zloty/cu m)						
Chemicals	Million PLN		1.95	2.03	2.12	2.21
Total Imported inputs (million of Nominal	Million PLN		**1.95**	**2.03**	**2.12**	**2.21**
Domestic inputs (including VAT in millions of Nominal Zloty)						
Power	Million PLN		19.66	21.18	22.81	24.58
Maintenance	Million PLN		8.15	8.78	9.45	10.19
Total Domestic Inputs (million of Nominal	Million PLN		**27.81**	**29.96**	**32.26**	**34.77**
INDIRECT INPUTS						
LABOUR						
Workers						
No. employed	Num#		250	250	250	200
Real Yearly wage (Zloty1999) per employee	PLN		60000	61200	62424	63672
Real Total Wages Cost Workers (millions of Zloty1999)	Million PLN		15.00	15.30	15.61	12.73
Supervisors and technicians						
No. employed	Num#		200	200	200	180
Real Yearly wage (Zloty1999) per employee	PLN		72000	73440	74909	76407
Real Total Wages cost Super/tech (million of Zloty1999)	Million PLN		14.40	14.69	14.98	13.75
Real Total Labour Cost	Million PLN		**29.40**	**29.99**	**30.59**	**26.49**
Nominal total Labour cost (million of	Million PLN		**29.40**	**32.05**	**34.94**	**32.34**

Figure 12: Operating Cost Calculations

Most of these calculations are based on production schedule of the project and it is determined as percentage of the production cost itself. The sales table is calculated based on the tariffs calculated and production schedule forecasted.

The final table calculated in this worksheet is the working capital necessary for the operations. In this particular case accounts receivables are a percentage of gross sales and accounts payable are calculated as a percentage of operating costs. The Cashbalance is a fraction of direct costs. These calculations are carried out in the ops. worksheet as Figure 13.

Working Capital (Nominal)						
Incremental case						
Accounts receivable	Million PLN		31.65	0.94	0.63	0.58
Change in accounts receivable	Million PLN		14.83	30.71	0.31	0.05
Accounts payable	Million PLN		7.41	0.15	0.15	0.15
Change in accounts payable	Million PLN		17.02	7.26	(0.00)	(0.00)
Minimum cash balance	Million PLN		4.90	0.10	0.10	0.10
Change in cash balance	Million PLN		2.63	(4.80)	0.00	0.00
Total case						
Accounts receivable	Million PLN		31.65	49.16	32.10	29.41
Change in accounts receivable	Million PLN		14.83	(17.52)	17.07	2.69
Accounts payable	Million PLN		7.41	7.39	7.38	7.36
Change in accounts payable	Million PLN		17.02	0.01	0.02	0.01
Minimum cash balance	Million PLN		4.90	4.89	4.88	4.87
Change in cash balance	Million PLN		2.63	(0.01)	(0.01)	(0.01)

Figure 13: Working Capital Calculation Table

3.4.4 Tax and Depreciation (T&D)

In the Tax and Depreciation worksheet two different depreciations and the future taxes are calculated. Economic depreciation is the real depreciation of assets in the project and is based on economic life of the assets. These calculations are carried out in the economic depreciation table (see Figure 14).

Depreciation (Economic)						
Machinery costs (Nominal PLN)	Million PLN		426.32	68.32	40.76	31.36
Miscellaneous fixed assets costs (Nominal PLN)	Million PLN		920.85	12.66	29.76	70.06
Machinery Depreciation (Nominal)						
Balance B/f	Million PLN			0.00	68.32	105.67
Addition	Million PLN	#Years	426.32	68.32	40.76	31.36
New assets Depreciation	Million PLN	20	21.08	0.00	3.42	2.04
Cumulative Depreciation	Million PLN		122.61	0.00	0.00	3.42
Balance C/f	Million PLN			68.32	105.67	131.57
Miscellaneous assets Depreciation (Nominal)						
Balance B/f	Million PLN			0.00	12.66	41.15
Addition	Million PLN	#Years	920.85	12.66	29.76	70.06
New assets Depreciation	Million PLN	10	79.92	0.00	1.27	2.98
Cumulative Depreciation	Million PLN		296.34	0.00	0.00	1.27
Balance C/f	Million PLN			12.66	41.15	106.97
Total Economic Depreciation	Million PLN		376.25	**0.00**	**1.27**	**4.24**

Figure 14: Economic Depreciation Table

This depreciation is used for determination of scrap value of project asset after the assumed appraisal time span.

The other factors that are determined in this part is the tax depreciation. The rate of depreciation for tax purposes are determined by government agencies or departments dealing with tax issues. The depreciation of different categories of assets are calculated in the tax depreciation table as Figure 15.

Depreciation (Tax)						
Machinery costs (Nominal PLN)	Million PLN		426.32	68.32	40.76	31.36
Miscellaneous fixed assets costs (Nominal PLN)	Million PLN		920.85	12.66	29.76	70.06
Machinery Depreciation						
Balance B/f	Million PLN			0.00	51.24	64.73
Addition	Million PLN	% p.a.	426.32	68.32	40.76	31.36
New assets Depreciation	Million PLN	25.00%	106.58	17.08	10.19	7.84
Cumulative Depreciation	Million PLN		301.73	0.00	17.08	27.27
Balance C/f	Million PLN			51.24	64.73	60.98
Miscellaneous fixed assets Depreciation						
Balance B/f	Million PLN			0.0	11.7	38.3
Addition	Million PLN	% p.a.	920.85	12.7	29.8	70.1
New assets Depreciation	Million PLN	7.50%	69.06	0.9	2.2	5.3
Cumulative Depreciation	Million PLN		282.19	0.0	0.9	3.2
Balance C/f	Million PLN			11.7	38.3	99.9
Total Tax Depreciation	Million PLN		**759.57**	**18.03**	**30.45**	**43.55**

Figure 15: Depreciation for Tax

In the last part of this worksheet the pro forma income tax statement of the project is calculated. In this table the calculations are based on incomes forecasted in the operation worksheet and tax depreciation. The Figure X shows the pro forma tax depreciation table.

Income Tax Statement (Nominal)			
Revenues			
Water sales(net)	Million PLN	-	3.53
Operating Expenses			
Total Wages	Million PLN	0.00	0.00
Chemicals	Million PLN	0.00	0.04
Power	Million PLN	0.00	0.21
Supplies & other exp.,maintenance	Million PLN	0.00	0.09
Gross Margin	Million PLN	-	**3.20**
Less asset tax depreciation	Million PLN	18.03	30.45
Earnings before interest & tax	Million PLN	(18.03)	(27.26)
Taxable income TIP	**Million PLN**	-	-
Income tax payment TIP	**Million PLN**	**0.00**	**0.00**
After Tax Earnings	**Million PLN**	**(18.03)**	**(27.26)**
Non Operating Expenses			
Less interest payments domestic loan A	Million PLN	-	-
Less interest payments domestic loan B	Million PLN	-	-
Less interest payments(EBRD)A	Million PLN	-	-
Less interest payments(EBRD)B	Million PLN	-	-
Equity holder's Taxable income	**Million PLN**	**(18.03)**	**(27.26)**
Equity holder's Income tax payment	**Million PLN**	-	-
Equity holder's After Tax Earnings	**Million PLN**	**(18.03)**	**(27.26)**

Figure 16: Income Tax Depreciation

3.4.5 Necessary Revenue

In this worksheet the necessary revenue for determining the tariff of water for different categories of customers is calculated. According to three documents concerning calculation of necessary revenue , obtained from web sites of Sianów (Gminne Wodociągi i Kanalizacja w Sianowie, 2013), Zalewo (Municipality of Zalewo, 2012) and Węgrów (Przedsiębiorstwo Wodociągów i Kanalizacji Sp. z o.o. w Węgrowie, 2013) cities and a standard developed by RTI and USAID (Research Triangle Institute, 2012) , the necessary revenue includes different factors like operating and maintenance costs, depreciation, interests, principals repaid, Cashbalance etc. These calculations were performed in necessary revenue table (see Figure 17). A thorough explanation regarding calculation of necessary revenue is provided in methodology section.

Necessary Revenue			
Operating and maintenance costs (nominal)	Million PLN	0.00	0.34
Depreciation (nominal)	Million PLN	0.00	1.27
Installments of capital (more than the value of depreciation)	Million PLN	0.00	0.00
Interest	Million PLN	0.00	0.00
Provision for irregular receivables	Million PLN	0	0
Total Loan drawdown in the year	Million PLN	44.10	36.37
Remaining value of asset (Economical)	Million PLN	80.98	146.82
Accounts payable	Million PLN	-	0.15
Cash Balance	Million PLN	-	0.10
The value of the necessary revenue	Million PLN	**1.13**	**4.97**
		60.20	68.56

Figure 17: Necessary Revenue Calculation Table

3.4.6 Cashflow

The Cashflow worksheet comprises four different Cashflow tables from two different points of view and in terms of nominal and real values. The first table calculates Cashflow from total investment point of view. From this point of view the soul investor of the project is assumed to be the banker to assess the overall profitability and sustainability of the investment without regards to allocation of profit and costs (see Figure 18).

CASH INFLOWS				
Revenue collected from Water		-	3.53	2.38
VAT Receipts		-	0.21	0.14
Change in Accounts Receivable		-	-	30.71
Liquidation Values				
Machinery		-	-	-
Miscellaneous Assets		-	-	-
Subsidy from the European Commission		161.06		
Total Inflows		**161.06**	**3.74**	**33.23**
CASH OUTFLOWS				
Investment (incl VAT and Import Duty on Foreign component):				
Machinery		68.32	40.76	31.36
Miscellaneous Assets		12.66	29.76	70.06
Operational Cost (including VAT and Import duty on chemicals)				
Total Wages	Million PLN	0.00	0.00	0.00
Chemicals	Million PLN	0.00	0.04	0.08
Power	Million PLN	0.00	0.21	0.45
Supplies & other exp.,maintenance	Million PLN	0.00	0.09	0.19
Change in accounts Payable	Million PLN	-	7.26	(0.00)
Change in Cash Balance	Million PLN	-	(4.80)	0.00
VAT Repayments	Million PLN	-	0.21	0.14
Income Tax Payments	Million PLN	0.00	0.00	0.00
Total Outflows	Million PLN	**80.98**	**73.52**	**102.28**
NET CASH FLOW	Million PLN	**80.08**	**(69.78)**	**(69.05)**
NPV Nominal TIP	Million PLN	(207.81)		

Figure 18: Cashflow Table from Total Investment Point of View

In the following table in worksheet, the Cashflow for equity holders is developed. From equity holder's point of view the loan disbursements are considered inflow and interest and principal repayments are regarded as outflows. In other two tables, the same Cashflow are calculated but in real terms.

Chapter 4

METHODOLOGY

4.1 Introduction

In this chapter a brief description and categories of projects and investments is presented. The history and objectives of CBA is offered, and then the different phases of lifecycle of projects, stages of appraisal are explained. After project lifecycle the comprising modules of an appraisal are defined.

In financial analysis part the main focus point are the decision criteria. After having decision criteria comprehensively discussed, economic and stakeholder analysis are briefly explained.

Since the sensitivity analysis is the main technique that the research is based on it, much more attention has been paid to sensitivity analysis than the other issues e.g. Monte Carlo simulation, Scenario analysis.

In the last part a brief explanation of how this research has been carried out is presented.

4.2 Investment Projects

In any investment the shareholders aim for an increased production of future goods by diverting the scarce resources used for current production of capital goods and any project as the smallest, separable investment unit that can be planned, financed, and implemented independently is defined as “any activity that involves the use of scarce resources during a specific time period for the purpose of generating a socio-economic return in the form of goods and services” (Jenkins, Kuo, & Harberge, 2012).

According to (Dayananda, Irons, Harrison, Herbohn, & Rowland, 2002) there are three categories of projects which are independent projects, mutually exclusive projects and contingent projects.

Selection or rejection of an *independent project* is not directly affected by other considered projects. In the appraisal of such projects acceptability of investment depends on the having positive value added for the firm. Adding a new product line while replacing another existing product line can be considered as independent projects.

Mutually exclusive projects are those that are considered as the alternatives for the same objective and cannot be implemented simultaneously. The criterion for selecting mutually exclusive project is adding more value to the firm. Choosing between two routes to build a road between to cities is an example of mutually exclusive projects.

Those projects that their approval is directly dependent on acceptance or dismissal of another project are called *contingent projects*. These kinds of projects have an enhancing effect on the outcomes. Adding a heat exchange unit to an electricity generation project is an example of contingent project.

4.3 Cost-Benefit Analysis (CBA)

Generally in the literature, CBA is considered as systematic method for assessing the profitability of allocating the scarce resources and this systematic approach instead of ad-hoc analyzing methods helps to maintain objectivity. Though, widespread use of this method starts from first decade of twentieth century, development of it goes back to ninetieth century when French civil engineer and economist, Jules Dupuit laid the foundation of this method in his 1848 article. (Johansson & Kristrom, 2012) The term appraisal is used when subject is a prospective investment and in the case of retrospective investments usually evaluation is used.

One of approaches in CBA is Integrated Investment Appraisal methodology established by Glenn P. Jenkins, Arnold C. Harberger and Chun-Yan Kou which has been applied in this research. This method comprises four main steps first of which is financial analysis, economic analysis, then stockholder analysis and finally the last step is risk analysis.

The appraisal offers support for decision makers by providing information and their analytical interpretations regarding the project. The UK's economics & finance ministry (2012) outlines the scope of this support as answer to two questions:

- Is the selected option superior to other available for achieving the defined objectives?

- Is the use of resources to realize objectives justified when resources could be exploited for other reasons?

The process of investment appraisal is carried out after each phase of the project and before each decision point but with different levels of detail. For each stage, CBA is carried out using estimations with various accuracies then if the project displays a favorable outlook then more accurate data are gathered and another analysis should be done evaluating the stance of the project. These calculations should be done even after detailed design of the project despite the fact that termination of the investment after this stage and after committing considerable amounts of resources is very difficult. This gradual increase in the accuracy and scope of assessment is a consequence of applying proportionality principal in appraisal process. By applying this principal the effort put into action is justifiable by resources available, end results and available time frame (UK's economics & finance ministry, 2012).

Appraisal of any project itself is composed of four steps that have been mentioned before. The first step is financial analysis that concerns the financial viability of the project throughout its intended life. After financial analysis, the next step is the economic analysis which has wider perspective and the cost and benefits of project are calculated from whole country's point of view. The third step of stakeholder analysis. In this step the potential gainers and losers of project are identified and amounts of these cost or benefits are calculated. Finally the last step is the risk analysis that deals with the uncertainty of project outcomes and their susceptibility to different factors.

A tendency towards separately analyzing these steps, especially the first three, is prevalent in other styles of cost benefit analysis. However a close link and interdependency is evident between them. For instance, in calculating the shadow price of a commodity, one needs to know its market price which is usually reported in the data that is used in the financial analysis or in order to assess the implications of a project for a special group of people or part of society, the required cost, benefits or prices are available in the economic analysis part of appraisal. These interdependencies demonstrate the need for an integrated approach to the appraisal of investment projects. (Jenkins et al. 2012)

4.4 Project Life Cycle

Generally every project is comprised of five different phases and four decision nods (Figure 3) from its identification till start of implementation. These five consecutive phases are idea and definition, pre-feasibility, feasibility and detailed design after successfully passing each decision cycle, are finally followed by project implementation.

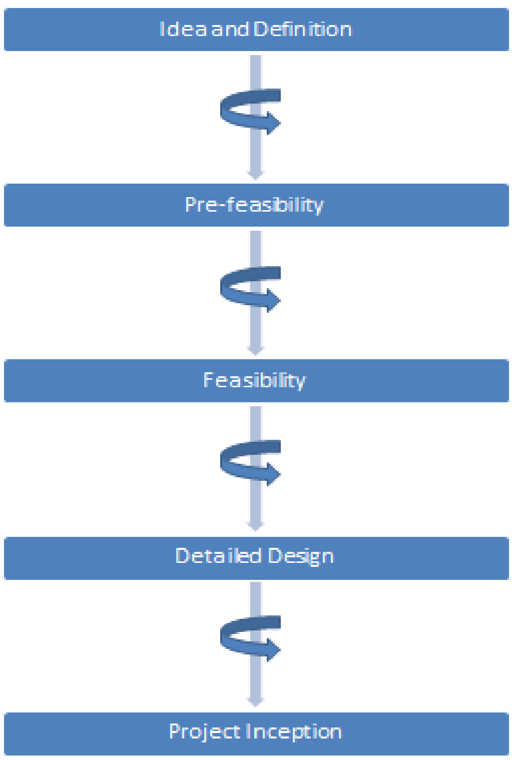

Figure 19: Project life cycle

(Source: Jenkins et al. 2012)

4.4.1 Project Definitions

This stage start with clear identification of need or opportunity that project is going to satisfy or utilize. According to In (Whelton & Ballard, 2002)in definition stage of projects there are some variables that are of selective nature and a reasonable range exist that decision makers have to choose the right value for them. Existence of such variables extends the role of project appraisal from just determination of overall profitability of project to verification of chosen values and providing the decision makers with a good vision of implications and results of their judgment. Financial design issues like distribution of benefits, costs or risks between stakeholders, interim credit shortfalls, scope efficiency or scale efficiency are some examples of issues that are affected by the decisions made in definition stage of the project or could be improved by means of them.

At the end of this stage a clear definition of goals, objectives, benchmarks and criteria for future evaluations should be provided.

4.4.2 Pre-feasibility

A basic assessment is made with the rough estimates of variables in this stage. At this stage because of unsophisticated nature of numbers used, the use of subjective and biased data is preferred to avoid unreasonable optimism. A cheap and quick way obtaining these data is utilization of secondary data. (Jenkins et al. 2012)

According to Jenkins et al. (2012) appraisal at this level composes:

a) Demand Module

b) Technical Module

c) Manpower Module

d) Financial Module

e) Economic Module

f) Environmental Module

g) Stakeholder Module

4.4.2.1 Demand Module

In this module the forecasts of likely quantities of sales, the prices associated with them, their trend throughout the life of project, sales taxes and export tariffs should be provided and classified in terms of domestic and internationally sold quantities.

This module should also offer an estimation of the amount of expected subsidies, relevant domestic and international regulations and predictions regarding development of new production technologies. (Jenkins et al. 2012)

4.4.2.2 Technical Module

Technical module offers the prices of each type of input, its quantity and sources throughout the life of project for both construction and operation phase. In addition to physical inputs the labor requirements of project in terms of category and type is provided in this module. In this module information regarding the economic life of the assets and their impact on environment should be provided.

4.4.2.3 Manpower and Management module

A labor market study of wage rate and availability of it for each occupation, skill level and sources of provision is required to have thorough module and any anticipated problem must be taken into account by revision of technical design or organizational capacity building before operation.

4.4.2.4 Financial Module

Unlike previous modules it depends on data provided in earlier modules and in preparing this module source of most data used are former modules. Cash flow profile of the project is considered as output of this stage. Other data being offered by this module are certainty level of items, influential factors, financing sources and financial viability of project. (Jenkins et al. 2012)

4.4.2.5 Economic Module

The cost and benefits obtained and calculated in this part are much comprehensive than financial module and equivalent items usually have different values, since other factors like tax, subsidies, pollution, etc. have been taken into account. Knowing the certainty level of data used in this part is of high value in future phases of the assessment.

After calculating the costs and benefits, economic cash flow of the investment should be constructed to calculate Net Present Value (NPV) of project from whole countries point of view i.e. the economic feasibility of project.

4.4.2.6 Environmental Module

The ultimate objective this module is to determine the cost-effective approach for easing the adverse effects of project that is being assessed. The process starts with identification and quantification of physical impacts then economic cost and benefits of such impacts are calculated. To compare alternative projects the economic cost of damage control measures should be compared with cost of damage itself for each alternative then the most cost effective one can be determined. (Jenkins et al. 2012)

4.4.2.7 Stakeholder Module

This part mainly involves Identification of stakeholder and impacts of the project on these parties and quantification of these impacts. Any unfair distribution of benefits or costs borne or operation should be improved or a compensating method should be devised to evade any difficulty in implementation of project. (Jenkins et al. 2012)

4.4.3 Feasibility Study

Feasibility study phase of project commences after acceptable values for indicators of project success is obtained in pre-feasibility stage. Since the information processed at pre-feasibility stage is rough estimates of variables, one major difference of this stage is in the accuracy of the data used. Process of assessment is augmented by adding a probability dimension to assumptions and carrying out sensitivity and Monte Carlo analysis to calculate the likely values of main project indicators and their statistical distribution. In other words, instead of using biased data to overcome uncertainty and over optimism, a statistical approach is being used in feasibility stage of appraisal. It is at the end of this stage that the acceptability of a project is concluded.

4.4.4 Detailed Design

Allocation of manpower, time and money to prepare a detailed design for a project is justified only if the project shows an acceptable performance in the feasibility stage. At the end of this process blueprints and operational, contingency and administrative plans should be prepared. It is the end of this stage where the acceptability of the investment is assessed for the last time. The UK's ministry of treasury, responsible for preparing the appraisal guidelines recommends that different procurement method like build operate transfer (BOT), build operate own (BOO), etc. should be taken into account in this stage (UK's economics & finance ministry, 2012).

4.4.5 Implementation

Throughout this phase of the project most of the responsibility and authority is granted to the project manager. He/she is responsible for allocation of available resources efficiently and effectively so the project is delivered on time, within the budget and according to expected quality. At the end of implementation phase, not only the physical construction should be completed but also the operational skills and organizational capacity should be built to a level that meets the requirements of the operation phase.

4.4.6 Ex-post Evaluation

The input for ex-post evaluation is real data and historic records in contrast to those of appraisal. Through this evaluation anticipations and estimates are compared with the reality to discover the short comings of appraisal techniques applied and propagate the advantageous ones. By this kind of evaluation not only the contribution of the project to set objectives is assessed but also variables from design and implementation stage that have significant effects on outcomes are identified for future appraisals. (Jenkins et al. 2012)

4.5 Financial analysis

Appraisal of any project is composed of four components that because of their sequential order they are also called appraisal steps. In this section a brief explanation of financial analysis is offered.

In this analysis the cash flow profile of the investment is generated to calculate different performance indicators of project regarding its viability and sustainability during its life span.

The length of interval during which the profitability of project is analyzed depends on many factors and the profile constructed in this analysis should cover this timespan, taking into account the influential factors.

Since the economic prices of the inputs and outputs of the project is calculated on the basis of market prices i.e. financial prices, this analysis is required even for those projects that are invested by the governments. According to Jenkins et al. (2012) ther are other reasons for this dependance and the most important reason is to find out whether sufficient funds exist or not. Also other issues are temporary cash shortfalls to cover the debt, insufficient fund in operating phase or problems in retooling and maintanence, etc. For example water supply projects deliver considerable economic profits for those who use the service but many financial issues likelow tariffs or late adjustments of tariff lead them to failure (Jenkins et al. 2012).

Though slightly different, cash flow profile as outline of financial performance of project has generic appearance. In the investment phase it is typically negative and a positive cash flow is prevalent in the operation and cessation phases.

4.5.1 Adjustment of Prices

The prices in the market change due to two different categories of driving forces. One change is in relative prices of goods and services in the market that are ruled by supply and demand law and these factors are two very important driving forces behind the change in the real prices in the market. Another category of price-change that occurs in the general level of prices is called inflation and happens due to fluctuation in the supply of money relative to the production of goods and services.

Because projects incomes and expenditures are distributed throughout the life span of the investment, the above mentioned forces and factors will become very important issues affecting the projects performance and their inclusion and prediction turns to be a key concern in project appraisal.

In this research a general method of dealing with inflation has been used that through dividing the current prices by change in the normalized price levels removes the inflationary component to get the real price of goods and services.

4.5.2 Time Value of Money

Any investment decision entails outlay of capital immediately or prior to its anticipated benefits. Hence, in order to take a sound decision regarding the investment it is necessary to adjust these values to account for factors like risk, uncertainty and timing.

The problem of non-comparability is the result of factors like risk, uncertainty, inflation, preference towards current consumption and investment opportunity. The overall effects of these issues that can enhance or erode the value of the money are summarized as time value of money (Jenkins et al. 2012). In order to take into account the effects of time value of money in the expenses accrued or benefits received in different timings their present or future values should be calculated. The calculation of present or future values is carried out by compounding and discounting methods.

4.5.3 Discount Rate

Discount rate reflects opportunity cost of capital that is defined as “the expected return foregone by bypassing other potential activities for a given capital” (Eropean Commission, DG Regional Policy, 2006). It transforms cost and benefits incurred or received in differing years to their present value.

From private sector’s point of view discount rate should reflect the rate of return from its second best investment opportunity that the investor is giving up. The rates of bonds or notes are good indicators of riskless time preference among those that are willing to give up their current consumption to reap future additional benefits. Since this rate takes into account the preferences of today’s investors, it can’t be applied to public project, because such an investment will affect the future flow of resources for next generations (Campbell & Richard , 2006). Furthermore (Campbell & Richard , 2006)put two other reasons for this ineligibility that are ill-defined property rights and distortions. Hence, choosing a social discount rate is more appropriate because, it takes into account the items like social time preference and social opportunity cost of capital that consider external cost and benefits to country as whole.

For social rate of return considers all country-wide issues like who lose and gain due to investment and also the attributable external effects, the same rate needs to be applied for all other options throughout country. Hence, responsible public agencies announce these rates, like rates that European Commission suggested for 2007-2013 period:

- 5% for Financial Discount Rate

- 3.5% for Social Discount Rate (non-eligible) (Eropean Commission, DG Regional Policy, 2006)

4.5.4 Decision Criteria

Having long lasting consequences and considerable effects, a sound investment decision requires a thorough and detailed analysis of the options available regarding their financial or economic profitability and sustainability. Hence, making such a decision call for reliable and robust performance indicators that can help decision maker to adopt the best option or at least evade steering the company or public resources to wrong directions. In following section these indicators will be briefly discussed.

4.5.4.1 Net Present Value (NPV)

Jenkins et al. (2012) defines the NPV as " The algebraic sum of the present values of the expected incremental net cashflows for a project over the project's anticipated lifetime".

The Eropean Commission, DG Regional Policy, (2006) explains this process of transforming different values accrued or gained in different years as carried out via weighting system that decrease the value of *numeraire* with time to reflect the loss due to time.

The discounting factor $a_t=(1+i)^{-t}$, that t stands for time, i for discount rate and is weight that is multiplied by values to get the present value (Eropean Commission, DG Regional Policy, 2006).

It is defined as:

Equation 10: NPV Formula

In this formula S_t stands for net of cash flow in year t.

Jenkins et al. (2012) categorize and interprete different NPV values as below:

- Zero NPV shows the recovery of cost and a return equal to second best alternative use of the capital

- A positive NPV stands for full recovery of expenditures and a higher return than alternative investment opportunity

- A negative NPV shows that the investment can’t recover its cost nor the opportunity cost of investment.

The NPV is considered as a very concise indicator of investment performance and it is not only be used for screening of projects but can also act as a ranking measures to choose those option that contributes the most to the future of investor of economy. This indicator is also used for choosing those projects that need a public support. For example European Union (EU) regulations ask for provision of evidence to show need for co-financing of EU funds and it is demonstrated by negative financial NPV of project.

4.5.4.2 Internal Rate of Return (IRR)

According to (Florio & Vignetti, 2003) the maximum disount rate that could be applied without bringing about the investment to a net loss is Internal Rate of Return (IRR) and this the point that the net present value of becomes zero. (Florio & Vignetti, 2003). (Magni, 2010) states that IRR was first mentioned by Keynes (1936) and Boulding (1935) (Magni, 2010).

The formula for IRR is:

Equation 11: IRR Formula

As stated by (Dayananda, et al., 2002) one conceptual shortcomming of IRR is that difficult to defint it on its own terms and defines it as “the rate of return at which all funds, if borrowed at the IRR, could be repaid from the project, without the firm having to make any cash contribution”. The other conceptual is the assumption of access to reinvestment opportunity at IRR rate for net income during the project life-time and it does not measure the contribution of investment to investors. Although the NPV criterion also assumes this reinvestment chance there is difference between them which lies in the discount rate of NPV is determined. In other words IRR is the answer for a mathematical equation but, discount rate of NPV is determined considering the current and anticipated conditions of market. (Dayananda et al. 2002)

According to Jenkins et al. (2012) the other problems of IRR is multiple IRRs for projects that need reinvestment and ranking or selection of mutually exclusive options with different size, timing and lifespan (Jenkins et al. 2012).

4.5.4.3 Benefit-Cost Ratio (BCR)

The benefit-cost ratio is calculated via dividing the present value of benefits by present value of costs. Hence, those options with rates higher than one are acceptable then they should be compared with other acceptable options and the project with highest ratio should be chosen. The formula of BCR is:

Equation 12: Benefit Cost Ratio

In this formula PV (I) is present value of inflows and PV (O) stands for present value of outputs. One drawback of benefit-cost ration is its sensitivity to classification method of cost and benefits. For example if a tax exemption is considered as benefit and added to benefits in numerator the ratio will be completely different than the case it is treated as a cost reducing item and subtracted from costs in denumerator. (Jenkins et al. 2012)

The other shortcoming of this criterion is its scale indifference, because a ratio and a ratio cannot convey any information regarding the dollar dimension of investment (Eropean Commission, DG Regional Policy, 2006).

4.5.4.4 Accounting Rate of Return

It is ratio of mean income investment benefit over cost. This is a misleading indicator that suffers lots of disadvantages like ignoring time value of money, scale indifference and utilization of accounting data that are not have direct relevance to added value for investor. (Dayananda et al. 2002)

4.5.4.5 Pay-back Period

It is the time spent to recover the initial capital investment. It is frequently used for business cases when there are political risks and the investors want to recover initial cost and reap benefits in a certain time frame or as soon as possible. This indicator puts premium on those in investments that have lower payback period, but the threshold according to which the options are screened should be subjectively determined by investors. It also doesn't take into account time value of money and ignores the costs and benefits of remaining years. In the cases where present value of cost and benefits is used, favoring quick yield to higher yield options seems unreasonable. (Jenkins et al. 2012)

4.5.4.6 Debt Service Coverage Ratio (DSCR)

The Public-Private Infrastructure Advisory Facility, (2012) defines the DSCR as "earnings before interest rate, depreciation and amortization divided by debt service" and considers it as the most important ratio for debt investors.

4.5.4.7 Loan Life Coverage Ratio (LLCR)

Throughout the time span that the project is paying the debt, there may be some years that project experiences shortfalls in cash inflow to service its debt. To assess the projects capability to cover these shortfalls LLCR is used by lenders in addition to other indicators like ADSCR or Project Life Coverage Ratio (PLCR).

Asian Development Bank's states the function of LLCR as follows:

> "This ratio shows, for any one operating year, the ability of the project company to accommodate an occasional shortfall of cash, leading to its inability to repay the debt during the last years of the project." (Asian Development Bank, 2012)

In contrast to PLCR which includes whole life of the project, this indicator assesses the ability of project to repay its debt till last payment of loan (Kistner & Price, 1999).The formula of LLCR is:

;

$$LLCR(t) = \frac{\sum_{t''=t}^{t_{0,comoper}+T_{repay}-1} \left[\left(CF_{PreFin}(t'') - tax_{inc}(t'') \right) \cdot (1+r)^{t-t''-1} \right]}{D - \sum_{t^*=t_{0,comoper}}^{t-0,5} D_{repay}(t^*)}$$

CF_{Prefin}	= Pre-finance cash flow
D	= Total debt at the start of commercial operation
$D_{service}$	= Debt service (interest and principal for the period)
D_{repay}	= Principal repayment of debt
tax_{inc}	= Income tax
t'	= full year period, t^* = half year period

4.6 Economic Analysis

In economic analysis the project is analyzed from much wider perspective than the financial analysis to help design and select the investments that contribute the most to the welfare of the whole society.

The net economic cost or benefit is calculated by adding up the all stakeholders gains and loses but, there are other differences between financial and economic cost benefit analysis. The differences are consideration of distortions, the scope of stakeholders that are taken into account and economic cost of capital.

4.7 Stakeholder Impact Analysis

The identification of losers and gainers any investment or intervention is one of main steps in the determining whether it is sustainable or not, because some stakeholders have the potential of inflicting sever damages to the profitability of investments or even barring its progression.

The objective of carrying a stake holder analysis is to identify the stakeholders and to quantify their share of profit or loss. Another aspect of this analysis is also the verification of projects ability to address the intended community's basic needs (Jenkins et al. 2012).

Given that the economic analysis covers the widest possible domain on country a level and relevance of financial analysis to a specific sub group of society, the difference between the results of these two studies reflects the unassigned share of project losses or benefit to those strata of community that have not been considered in preceding stages of appraisal process. It is this portion of losses or benefits that stakeholder analysis deals with. The differences between financial and economic values, also called externalities, represent the accrued cost to or gained benefit by parties other than main stakeholders.

According to Jenkins et al. (2012) Steps of stakeholder analysis are as follows:

1. Identification of externalities

2. Quantification of externalities

3. Calculation of present values (PV)

4. Allocation of appropriate share of PVs to parties involved

5. Summarization

6. Reconciliation

The final result of this analysis is the answer to question of who gains, who loses and by how much. Then in the case of any disproportionately distribution of losses or benefit, the designers of project should come up with better schemes of that evades such problems or enough preventive measures should be taken for any future conflicts.

4.8 Risk Analysis

The guideline of CBA of European Commission states that "appraisal is a forecasting exercise rather than formulation of an opinion" and point out the uncertainty inherent in the every forecasting attempt (Eropean Commission, DG Regional Policy, 2006). In addition to the deterministic nature of the models developed in appraisal processes, all other stages before risk analysis have assumed a point value for the inputs assumptions. The stage witch such an uncertainty is taken into account is the risk analysis stage.

There are three levels of uncertainty, first of which is the uncertainty of existing data and even with access to accurate data, because of time factor involved in prediction there is always a degree of uncertainty remaining in all forecasts. The second level is faced when there are no probabilities that could be attached to the expected values. The highest level of uncertainty materializes when there is no available historical data or expert views (Jenkins et al. 2012).

Given the infinitesimal realization chance of any point-estimate of parameters, a statistical and probabilistic approach should be employed. In other words, instead of deterministic and single values, expected values or frequency distribution of input data should be used that in turn will provide analysts with the pattern of likelihoods of outcomes.

Some resources consider risk analysis just as an exploratory study in contrast with other literature which assume a prescriptive nature for this study as well, for example economic analysis guide line of Asian development bank define risk analysis limited to identification, quantification and analysis of data to get the likelihood of different values or European commission in its CBA guideline defines the risk analysis as "A risk assessment consists of studying the probability that a project will achieve a satisfactory performance" (Eropean Commission, DG Regional Policy, 2006). Whereas Jenkins et al. (2012) added another aspect to risk analysis and consider the interpretation and impact analysis of risks as an integral part of it.

According to other resources Risk analysis could have further aspects and wider scope. For example the demand for project or the distributional impact of the project can be subjected to uncertainty and analyzed. In case of comparison or prioritizing alternatives, the best alternative or one with least cost should be examined to find out whether it keeps its position in different scenarios or not (Asian Develpment Bank, Economics and Development Resource Center, 1990).

The risk analysis results not only facilitate and support the decision making process but also contributes to preparation of contracts and also it helps to cost-effectively invest for reduction of uncertainty.

European Commission sets steps of risk analysis forth as:

1. Assuming that risky variable are characterized not only by uncertainty surrounding them but also by their important role, identification of risk variables is carried out through sensitivity analysis.

2. After the identification of risk variables then if there are primary or secondary research should be sought. This procedure leads to frequency distribution of these parameters.

3. In this step the data provided in last step, after some fine tunings and final touches like application of relevant correlations or consideration of contractual truncations, are analyzed with risk analysis techniques that in this research is Monte Carlo method.

4. After delivery of analysis results, the decision makers carry out primary screening based on the attitude of stakeholders towards risk.

5. Finally the risk management and prevention methods like risk allocation, risk diversification, additional contractual clauses and further investment for more accurate data are considered.

4.8.1 Sensitivity Analysis

According to Environmental Protection Agency, Office of Solid Waste and Emergency Response (1999) "Sensitivity analysis, as it is applied to risk assessment, is any systematic, common sense technique used to understand how risk estimates and, in particular, risk-based decisions, are dependent on variability and uncertainty in the factors contributing to risk." (Environmental Protection Agency, Office of Solid Waste and Emergency Response, 1999).

The identification of influential factors as the first step in risk analysis is carried out through sensitivity analysis. However another application of sensitivity analysis is in the model verification which may be utilized before start of the risk analysis phase of the appraisal. In its basic form sensitivity analysis is the calculation of outcomes and its fluctuations by changing one parameter at a time.

Sometimes a variable may have wide possible range of values but don't have a considerable impact on outcomes and vice versa. Hence, the main issue is the extent of impact a variable can have on the outcomes of project. A risk factor has to have two characteristics in order to be accepted as a risk variable which are being uncertain and having considerable impact on the final outcomes of the project. But, it should keep its influential position throughout the range of possible value.

The basic form of sensitivity analysis has some shortcomings which are the lack any probabilities attached to anticipated outcomes and inputs, having the capacity of assessing only one at a time parameter's change or in other words no combined effect of parameters is determinable and the other problem is that no correlation between variables is applicable. But there are other methods of sensitivity analysis that have overcome some of these shortcomings and an extensive review of these methods have been provided in the literature review chapter.

4.9 Calculation of Tariff and Necessary Revenue

The necessary revenue is the amount that when divided by next years estimated demand equals to the tariff for next year. In this research methods used in three documents retrieved from water and sanitation companies' web sites of Sianowe, Zalewo and Węgrów cities in addition to a standard developed by RTI and USAID were applied for calculation of necessary revenue. The following show the constituent components of necessary revenue.

Necessary revenue = Operating and Maintenance expenses + Capital installments more than Depreciation + Interest + Profit Margin + non-regular Revenue

Operating Expenses = Direct Costs + Indirect Costs

Direct Costs = Depreciation + Wages + Material + Energy + Fee for use of Environment + Tax + Outsourcing + Other Costs

Indirect Costs = Departmental Costs + Overheads

The method recommended in the standard developed by USAID and RTI is included as XLS format and attached to the thesis.

4.10 Application of Methodology on the Case Study

In this research, in addition to the uncertainty surrounding the predicted values of inputs for coming years two more aspects of uncertainty have been taken into account. In order to assess the impact of the regulatory risk that in this case is the adoption of cost recovery method, two more variables have been added which are the imposition year of the new regulation and number of factors that are allowed to be included in the tariffs.

As the first step, a financial model of the Bydgoszcz water supply project was prepared using African Development Bank Group's template and also some flaws of previous model regarding loan repayments were resolved. Then a necessary revenue part was added to the in which the necessary revenue of each year is estimated based on previous years expenses. The method used for calculation of necessary revenue is based on three documents obtained from water and sanitation company web sites of Sianowe, Węgrów and Zalewo cities. The other source that was used for preparation of necessary revenue is a standard developed by Research Triangle Institute (2012).

Throughout this procedure the framework and principals of integrated investment appraisal, set forth by Jenkins et al. (2012), have been applied. Regarding the format of model, the African Developmetn Bank's template for financial models was utilized due to its better structure that is more comprehendible and verifiable.

After developing the financial model, the Monte Carlo simulation is carried out on the model using Crystal Ball software. Through Monte Carlo simulation, different sets values for each factor are derived from their probability distributions, as much as 10000 different combinations. Then for each set of values the model is run to calculate the relating output. Afterwards the probability distribution of model output is calculated via these results.

To solve the problem of anticipated change in tariff calculation the following approaches are employed.

To account for the uncertainty of imposition year, one discrete factor has been added to the model which is the imposition year of the new regulation. By changing this value the model alters its method of tariff calculation from the former method to cost recovery method for the coming years and also the current year as well. For example if the imposition year is adjusted to 2005, then the model uses the tariffs calculated according to previous method and applies the cost recovery tariffs for 2005 till 2010. There is also an option to use the 2011 as the year of adoption, by using this value the model considers the scenario of non-adoption case.

To account for the other aspect of the risk, an indirect approach has been used which is the utilization of a capacity in the sensitivity analysis. Although sensitivity analysis in its basic form has many shortcoming and is just used for identification of influential factors in the project, but there other sophisticated sensitivity analysis method that have been covered in the previous sections. The sensitivity analysis method employed here is SRCC which is a statistical method based on simulation of the model. This method has its own merits that lead to adoption of it in this research. These merits are its capability of allocating variance of output to inputs, applicability to data that are non-linearly associated and its independence of normality assumption of underlying population.

By utilizing the SRCC the impact of the inclusion and exclusion of different cost items have been assessed. By calculating each items contribution to variance different scenarios have been depicted in color coded tables that show whether such an uncertainty really matters in that specific year or not.

Then outputs of Monte Carlo simulation are rearranged and refined to include only the data that are useful in our study. The outputs concerning the shape of distribution were used to determine which central tendency measure represents the whole possible range as the best measure. After this selection, the pertinent graphs of NPV and its standard deviation have been drawn. These graphs illustrate how the adoption of new regulation would affect the profitability and riskiness of the project.

In this research the sensitivity of the project output different risk variables is measured through SRCC but, to give make them more understandable and interpretable these values have been squared to clear the sign of the coefficient and then they were normalized to show the different parameter’s relative impact on the output. The negative or positive sign of the coefficient is an indicator of whether the change in the input value is affecting the output in the same way or not i.e. whether increase of input value leads to increase in output or decrease.

After performing the simulation for all eleven years and computing the relevant statistics for each of four different project outputs, the results of sensitivity analysis are depicted in tables of contribution to variance. These tables are color-coded to better communicate how the adoption of the new regulation is affecting the sensitivity of project to different input variables.

Chapter 5

RESULT & DISCUSSIONS

5.1 Introduction

In this chapter the investment outcome indicators, uncertainty surrounding them and contribution of different factors to this uncertainties are evaluated from two points of view which are equity holder's point of view and total investment point of view. Also both incremental and total approaches are evaluated.

For each point of view a brief description is offered then the effect of adoption of new regulation on the overall profitability is discussed. Both aspects of regulation effects, namely reduction in risk and profitability are discussed via cost of risk reduction index graphs. This indicator integrates both aspects of effects in a single one.

Then the changes in levels of contribution to variance of output due to different adoption years have been evaluated for different factors and any difference and inconsistency in the results are justified. A summary of results is presented in the succeeding section.

Finally the interpretation and implication of this regulatory change have been discussed in the last section.

5.2 Results of Analysis

Throughout this research, implications of adopting cost recovery method on risk and uncertainty of water distribution projects have been the main focus. Therefore, the results pertaining to risk simulation are of paramount value and other economic and stakeholder consequences are excluded.

The following tables include the statistics of probability distribution of financial NPV and different factor's contribution to variance NPV from two different points of view and through both total and incremental approaches

In order to demonstrate the effects of uncertainty surrounding the imposition year of the regulation and the number and nature of parameters included, the following sections will provide the tables of relevant project outcome data that are the results of different imposition years and contribution to variance tables of anticipated risk factors.

In this research the parameters considered in the Mont Carlo and sensitivity analysis have been classified in terms of their impact on the cash flow and also in terms of their position in the contribution to variance tables.

The classification in terms of impact on the cash flow divides the parameter in two groups, revenue-generating and non-revenue-generating parameters.

The other classification splits the parameters to constantly-significant, switching and constantly-insignificant parameters. Constantly significant parameters are those which remain significant in sensitivity analysis from all of viewpoints i.e. annual industrial consumption change, annual per capita consumption change, exchange rate appreciation and depreciation rate and change in the percentage of direct expenses for cash flow calculation.

The switching parameters are those that sensitivity of outcomes to them depends on the cash flow point of view and application of total or incremental approach i.e. all of domestic tariff adjustment rate and industrial adjustment rate for years 2000-2002.

Constantly-insignificant parameter’s influences on cash flow stay unimportant from all points of view i.e. industrial tariff adjustment rate for 2003-2010, LIBOR, WIBOR, power growth rate, wage growth rate and lag in payments and collection.

For easier interpretation of contribution to variance tables (Table 6, 8, 10 and 12) the data are color-coded to render them more understandable. In these tables, variables with less than one percent contribution are green and the remaining is white to differentiate between influential and insignificant ones.

In order to combine both aspects of the regulation’s effect on project, the cost of risk reduction has been suggested. These aspects are the changes in standard deviation and change in mean NPV of project. Through dividing the difference between the each year’s standard deviation with the standard deviation of non-adoption case (adoption on 2011) by the difference of their NPV the cost of risk reduction is calculated.

The abbreviations used for risk factors are as follows:

- **Annual industrial consumption change rate** is the annual decrease or increase in the industrial water demand.

- **Annual per capita consumption change rate** is the annual variation in domestic per capita demand.

- **Exchange rate appreciation or depreciation** is the increase or decrease in the exchange rate between PLN and US$.

- **Cashbalance** this rate shows the annual change in cash balance which itself is the amount of money that should be used in order to carryout daily transaction. It is calculates as percentage of direct costs (wages, power, maintenance and chemicals).

- **Domestic 99-10** are assumed changes in the annual tariff of domestic water from 1999 till 2010.

- **Industrial 99-10** are assumptions regarding change in industrial water tariff for 1999 till 2010.

- **LIBOR** is an interbank interest rate determined by London banks' lending rate. This rate is usually used as up to date measure of interest for loans and the interest that should be paid by borrower is this rate plus a fixed amount.

- **Payable-lag** is change in the percentage of outflows that is paid later than its due date. In this case the base case is 25% and Payable-lag stands for change in this base case assumption.

- **Receiv-lag** is the change in the percentage of inflows that is paid to the project owner later than its due date. In this case the receivable is 25% of gross sales and Receiv-lag represents the change in the base case assumption.

- **Power-growth** is the annual increase in the price of electricity

- **Wage growth** is the annual increase in wages

- **WIBOR** is the same as LIBOR but unlike LIBOR which is global indicator, it is national level indicator of interest and applies only to Poland and PLN. In the case of this project Polish Commercial Banks supply loans to project at a interest rate that is calculated as WIBOR + 6%.

5.2.1 Incremental Approach

One of the main principals of investment appraisal is to analyze those effects that are traceable to the new project rather than the whole after project situation. In other words only those effects that exist with project and will vanish without it should be taken into account.

5.2.1.1 Equity holders point of view

From this point of view financial flows like loans received, grants or tax exemptions etc. is considered as cash inflow and outflows treated almost the same as Banker's point of view. This is equal to the flow of cash to those who own the project and usually receive their share after all loans and other obligations of the project have been paid.

In Table 5 the values of skewness which are quite close to zero and similarity of mean and median indicates the symmetry of frequency distribution which in turn suggests the mean as a fair measure of the whole data set. By considering the increase in mean through 1999 to 2010 (see figure 4), the adverse effect of cost recovery method adoption is obvious. The table 5 shows that the later the regulation is adopted the better the NPV of the project becomes.

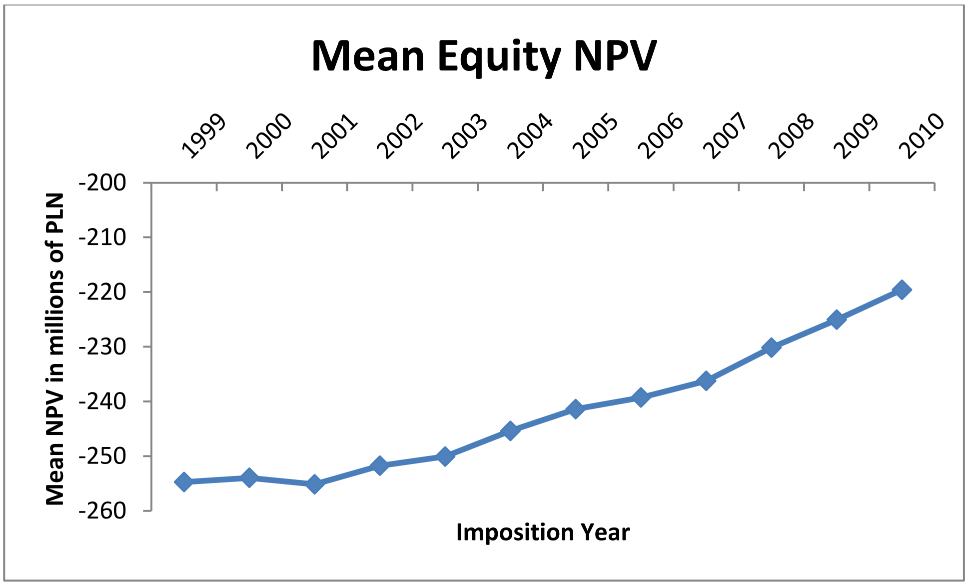

Figure 20: Equity holdr's NPV for different imposition scenarios

Table 4: Main statistical indicators of equity holder's NPV

Main statistical indicators of Real EQUI NPV													
Imposition Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Trials	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Mean	(254.75)	(253.97)	(255.17)	(251.76)	(250.09)	(245.40)	(241.42)	(239.29)	(236.25)	(230.17)	(225.05)	(219.60)	(220.14)
Median	(256.58)	(256.03)	(256.38)	(254.18)	(252.16)	(247.39)	(243.44)	(240.88)	(237.95)	(231.39)	(225.33)	(221.28)	(221.85)
Standard Deviation	74.05	73.99	74.34	73.88	74.32	74.13	74.10	74.96	74.93	74.65	73.79	75.04	75.19
Variance	5,483.37	5,474.61	5,526.39	5,457.55	5,523.62	5,495.27	5,490.70	5,618.67	5,614.65	5,572.70	5,444.29	5,630.59	5,653.95
Skewness	-0.0422	-0.0410	0.0029	-0.0054	-0.0070	-0.0260	-0.0256	-0.0132	-0.0130	-0.0496	-0.0372	-0.0358	-0.0320
Kurtosis	2.10	2.08	2.06	2.10	2.07	2.11	2.10	2.08	2.07	2.10	2.13	2.08	2.08
Coeff. of Variability	-0.2907	-0.2913	-0.2913	-0.2934	-0.2972	-0.3021	-0.3069	-0.3133	-0.3172	-0.3243	-0.3279	-0.3417	-0.3416
Minimum	(460.86)	(450.53)	(444.30)	(445.89)	(437.38)	(450.28)	(435.90)	(432.25)	(437.95)	(426.16)	(420.91)	(428.30)	(415.31)
Maximum	(89.43)	(79.87)	(77.33)	(78.94)	(70.78)	(65.39)	(73.00)	(62.28)	(51.78)	(50.47)	(45.72)	(44.23)	(39.41)
Range Width	371.43	370.66	366.97	366.95	366.60	384.89	362.90	369.97	386.17	375.69	375.19	384.06	375.90
Mean Std. Error	0.74	0.74	0.74	0.74	0.74	0.74	0.74	0.75	0.75	0.75	0.74	0.75	0.75
cost of risk reduction	28,089	30,449	19,606	36,127	23,482	35,154	42,981	4,033	6,380	36,569	229,317		

The other indicator that worth noting is the risk reduction cost. Although no monotonic change is evident in this figure, but still it can be used as a mean for rough assessment of price-efficiency of the regulation adopted in different years or to compare different alternatives. (See figure 5)

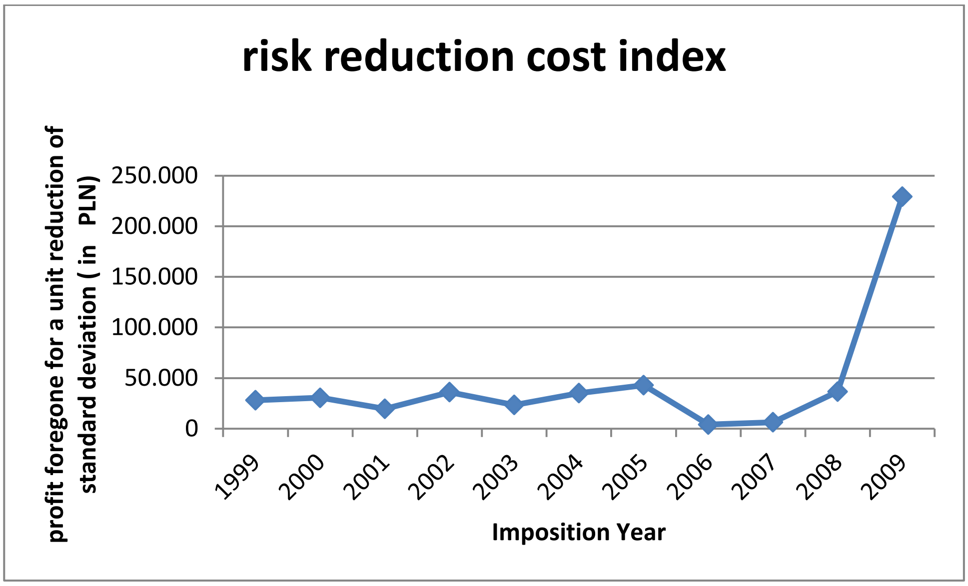

Figure 21: Risk reduction cost index for equity holder

Table 6 shows that adoption of the new tariff calculation method doesn't change the sensitivity of outcomes for assumed parameters. In other words, the significant parameters remain significant and other playing minor roles remain unimportant, no matter when the regulation is adopted.

This is because of two reasons one is the low amount of incremental inflow generated by investment relative to its cost and the other is the repayment of the loans during the project appraisal period. Since loans are obtained in a few disbursements (usually one or two) but repayments are distributed evenly over much longer years, the cash flow profile of the loan is much like an even negative flow with one or two positive peak points. This loan repayment profile shape adds to the problem of unproportionate amounts of out flow and inflow. By way of explanation, the expenditure incurred is so higher than incremental revenues generated that the revenue-generating parameters are not able to have a considerable effect on the NPV of the project, therefor any tariff determination method including cost recovery method that eliminates the need for predetermined adjustments cannot change the financial status of the project.

Table 5: Contribution to variance of equity holder’s NPV

Contribution to Variance of Real EQUI NPV												
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Annu_Ind_Consum_Rate	0.95	0.93	0.94	0.94	0.93	0.94	0.94	0.94	0.93	0.94	0.94	0.94
Annu_per_cap_Consum_Rate	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.03	0.04
App_Dep_factor	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.02
cashbalance	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01
domes00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LIBOR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
payable_lag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
power_growth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
receiv_lag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wage_growth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WIBOR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

5.2.1.2 Banker's point of view

Banker's point of view is usually used by financiers to get the overall profitability of investment given that project is going to be funded only with capital provided by bank and with cost of capital equal to loan's interest rate. The main difference between equity holders and Banker's point of view is the inclusion of loan and repayment of its principal and interest in equity holder's cash flow.

The slight difference between mean and median and existence of non-skewed mean in table 7 makes the mean a sound indicator for central tendency of the data. Then, the detrimental effect of new regulation on this project is realized by the monotonic increase of NPV in figure 6.

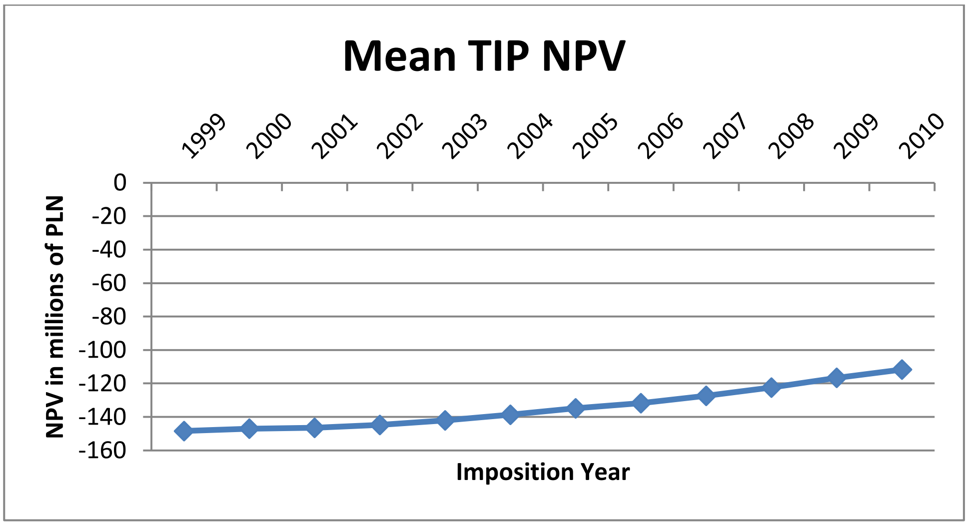

Figure 22: Total investment NPV for different imposition scenarios

Table 6: Main statistical indicators of total investment NPV

Main Statistical indicators of Real TIP NPV												
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trials	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Mean	(148.44)	(147.00)	(146.51)	(144.78)	(142.06)	(138.70)	(134.87)	(131.77)	(127.39)	(122.46)	(116.60)	(111.68)
Median	(148.23)	(146.74)	(146.30)	(144.50)	(141.83)	(138.52)	(134.68)	(131.48)	(127.12)	(122.25)	(116.40)	(111.57)
Standard Deviation	6.65	6.68	6.69	6.67	6.63	6.67	6.74	6.78	6.77	6.82	6.98	7.09
Variance	44.18	44.61	44.71	44.54	43.99	44.47	45.41	46.03	45.88	46.55	48.78	50.32
Skewness	-0.1549	-0.1685	-0.1284	-0.1708	-0.1527	-0.1498	-0.1430	-0.1527	-0.1601	-0.1438	-0.1431	-0.0862
Kurtosis	2.37	2.38	2.37	2.40	2.44	2.42	2.39	2.38	2.42	2.46	2.40	2.50
Coeff. of Variability	-0.0448	-0.0454	-0.0456	-0.0461	-0.0467	-0.0481	-0.0500	-0.0515	-0.0532	-0.0557	-0.0599	-0.0635
Minimum	(166.63)	(165.05)	(165.90)	(164.10)	(160.71)	(157.73)	(152.98)	(151.10)	(147.59)	(142.27)	(137.63)	(131.95)
Maximum	(131.39)	(129.81)	(128.04)	(126.93)	(124.62)	(121.10)	(118.44)	(114.50)	(109.68)	(103.68)	(97.87)	(90.30)
Range Width	35.24	35.24	37.85	37.16	36.09	36.64	34.55	36.60	37.91	38.59	39.76	41.65
Mean Std. Error	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
cost of risk reduction	12142	11723	11680	12675	15171	15722	15311	15391	20353	25134	22246	

Also in figure 7, there is an evident steady decrease in cost-efficiency of risk reducing capability regulation. In other words, if the decision makers consider the implications of new regulation regarding predictability of project benefits, the data depicted in figure 7 demonstrate the decreasing efficiency of the decision in different years. The sooner the adoption the cheaper the risk reduction will become.

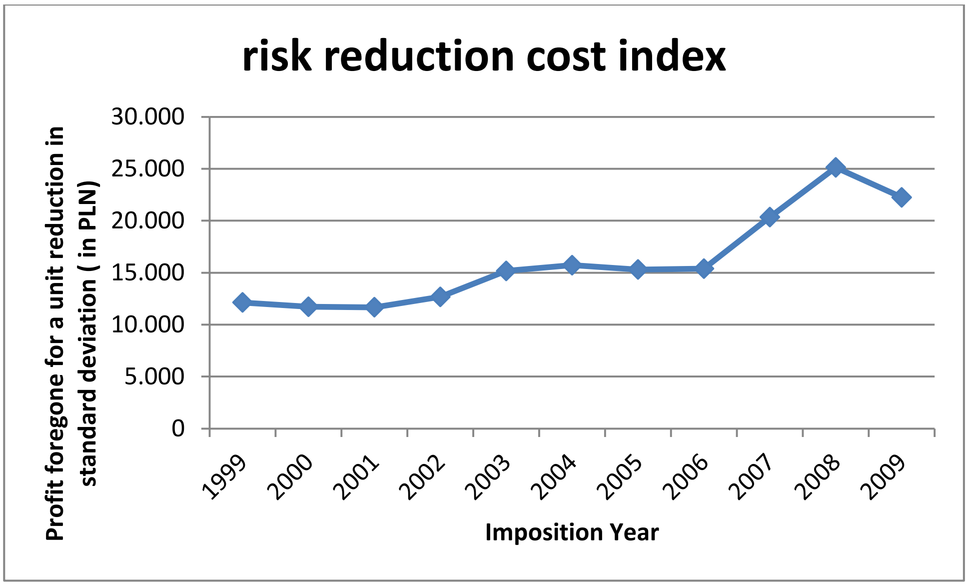

Figure 23: Risk reduction cost index for total investment

The table of contribution to sensitivity (table 8) demonstrates a decrease in the number of factors that can affect the outcome of the project for the bankers. Consequently fewer number of influential parameter means fewer factors that need to be predicted or estimated. For example if the project owner want to outsource a research to estimate the future trends of significant factors, the adoption of regulation will reduce the cost of such researches simply by reducing the number of them.

Table 7: Contribution to variance of total invesment NPV

	Contribution to Variance of Real TIP NPV											
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
annual industrial consumption change rate	0.92	0.91	0.91	0.91	0.91	0.91	0.90	0.90	0.90	0.89	0.88	0.85
annual percapita consumption change rate	0.05	0.05	0.04	0.05	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.04
exchange rate appreciation or depreciation	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.03	0.03
cashbalance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
domes00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
domes01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.01
domes02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
domes03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
domes04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
domes05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
domes99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
indus99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LIBOR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
payable_lag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
power_growth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
receivable_lag	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wage_growth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WIBOR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

This regulation also concentrates the contribution of remaining parameters in a specific one that in this case is annual industrial consumption change rate. This concentration of influentially can be grasped from figure 8. For example the contribution to variance of annual industrial consumption change has increased from 0.85 to 0.92.

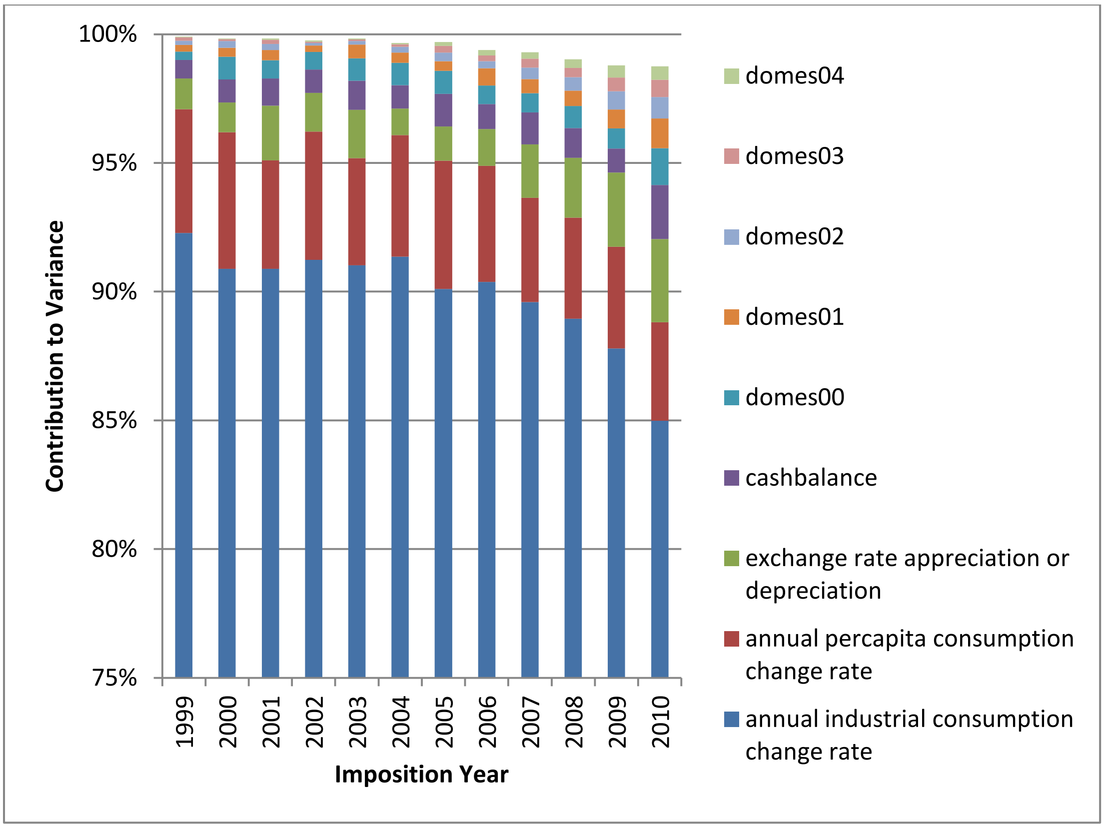

Figure 24: Contribution to variance of total investment NPV

Therefore, this regulation not only reduces the number of important parameters but also allocates this importance between remaining parameters in such a way that makes important ones even more influential. This gives the decision makers the opportunity to prioritize the parameters and decide which one should be investigated first and more to get less inaccurate estimates.

5.2.2 Total Approach

The second approach in CBA is study of project not as an incremental part of existing structure but rather as an integral part of it. In this approach the cash flow of new facility is analyzed together with cash flow that would exist without the project.

5.2.2.1 Equity holders point of view

The summary and symmetry statistics of analysis pertaining to whole water distribution system in place along with newly constructed portion is summarized in Table 9. Again, based on the close to zero skewness and similarity of mean and median in addition to close to 3 kurtosis values, mean has been selected to represent the set of data. To demonstrate the adverse effect of the new regulation is depicted in the figure 9 which shows an approximately 70% decrease in the mean value of NPV to the owners of the project.

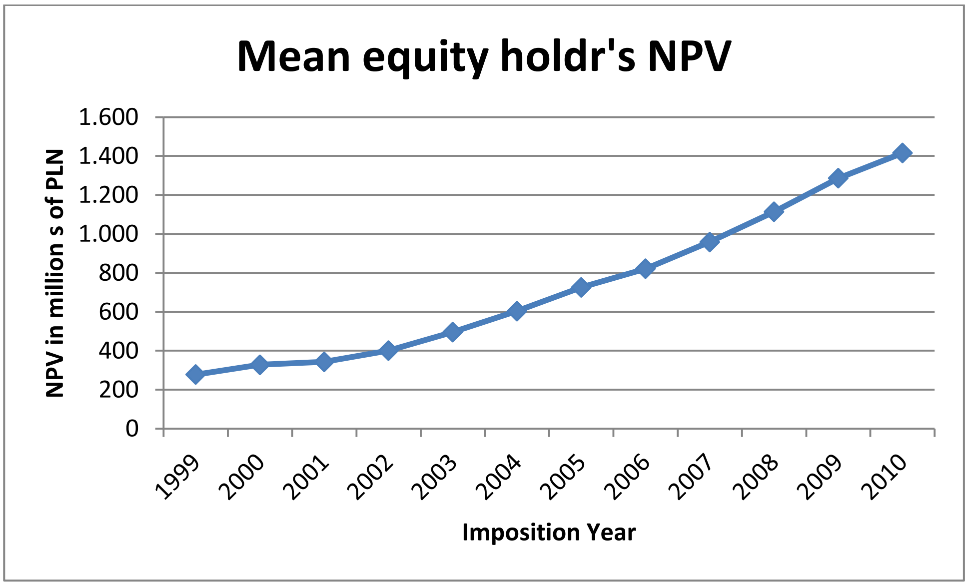

Figure 25: Equity holder’s NPV for different imposition scenarios

Table 8: Main statistical indicators of Equity holder's NPV

Main statistical indicators of Real EQUI NPV												
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trials	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Mean	277.98	327.47	342.89	400.68	495.69	603.34	725.26	821.47	958.18	1,113.88	1,286.48	1,415.95
Median	272.20	321.44	337.33	395.60	491.13	599.97	721.67	819.65	957.38	1,113.12	1,285.44	1,416.24
Standard Deviation	48.57	49.04	48.47	49.81	52.56	56.90	61.99	65.51	72.53	81.24	92.10	99.09
Variance	2,359.50	2,405.08	2,349.08	2,481.42	2,762.57	3,237.52	3,843.03	4,291.67	5,261.00	6,600.12	8,483.23	9,818.05
Skewness	0.2173	0.2301	0.2340	0.2112	0.1849	0.1354	0.1410	0.0971	0.0428	0.0356	0.0281	0.00
Kurtosis	2.01	2.02	2.07	2.12	2.20	2.29	2.40	2.48	2.61	2.60	2.64	2.76
Coeff. of Variability	0.1747	0.1498	0.1413	0.1243	0.1060	0.0943	0.0855	0.0797	0.0757	0.0729	0.0716	0.0700
Minimum	177.90	225.20	237.70	287.54	361.65	441.20	530.31	620.54	726.85	834.20	970.54	1,049.82
Maximum	393.85	441.01	472.36	527.74	647.55	767.79	955.70	1,016.16	1,194.41	1,368.47	1,579.36	1,789.49
Range Width	215.96	215.81	234.66	240.20	285.90	326.59	425.39	395.62	467.56	534.27	608.82	739.66
Mean Std. Error	0.49	0.49	0.48	0.50	0.53	0.57	0.62	0.66	0.73	0.81	0.92	0.99
cost of risk reduction	44387	45976	47173	48531	50557	51915	53706	56479	58006	59076	53924	

The cost of risk reduction is being reduced due to sooner application of new method as it's easily apprehended from figure 10.

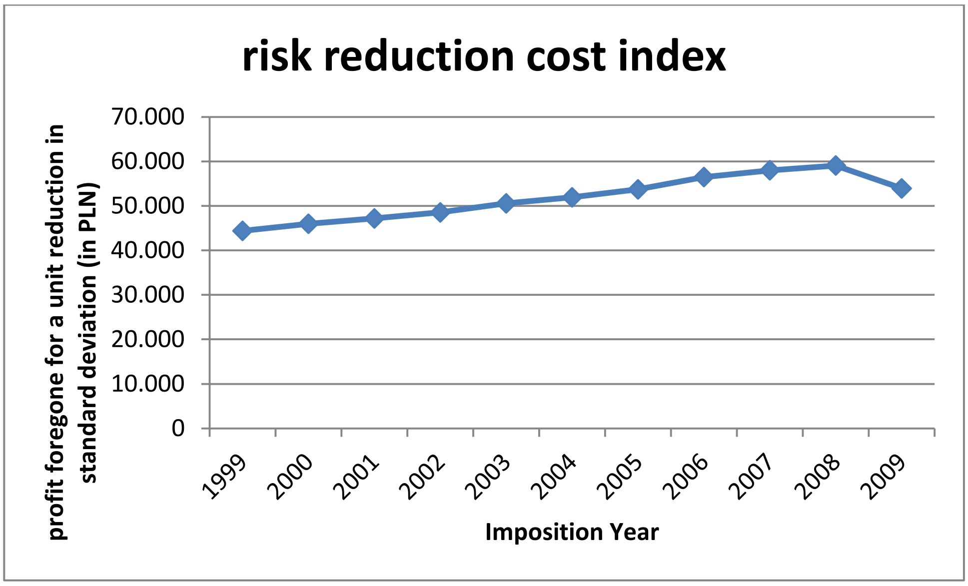

Figure 26: Risk reduction cost index for equity holder

This almost monotonic increase in risk reduction cost index shows that the efficiency of risk reducing potential of regulation is decreasing. In other words, the sooner the regulation is adopted the cheaper its benefit will be harnessed.

The color coded table of contribution to variance (Table 10) demonstrates how the project's susceptibility to the uncertainty surrounding different parameters changes due to new regulation. Such an evident reduction in the number of influential parameters leads to a drop in the expenses that owners need to incur to obtain better and more accurate estimates of critical parameter's future trend.

Table 9: Contribution to variance of equity holder's NPV

Contribution to Variance of Real EQUI NPV												
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
annual industrial consumption change rate	97%	97%	94%	93%	89%	85%	81%	71%	65%	61%	57%	56%
annual percapita consumption change rate	1%	2%	2%	3%	4%	4%	6%	9%	11%	12%	13%	13%
exchange rate appreciation or depreciation	1%	1%	2%	1%	2%	4%	4%	5%	7%	7%	8%	8%
cashbalance	0%	0%	1%	1%	1%	2%	3%	5%	5%	6%	8%	8%
domes00	0%	0%	0%	1%	1%	2%	2%	3%	3%	4%	4%	4%
domes01	0%	0%	0%	0%	1%	1%	1%	2%	3%	3%	3%	2%
domes02	0%	0%	0%	0%	0%	1%	1%	2%	2%	1%	2%	2%
domes03	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%
domes04	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%
domes05	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
domes06	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
domes07	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
domes08	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
domes09	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
domes10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
domes99	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus00	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus04	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus05	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus06	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus07	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus08	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus09	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus99	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
LIBOR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
payable_lag	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
power_growth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
receiv_lag	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
wage_growth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
WIBOR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Besides, sooner adoption of regulation also causes a concentration of contribution to variance in one of parameters i.e. not only the number of critical parameters are decreasing but also the remaining parameters with higher effect on results become more influential. For example, an expense incurred to obtain better estimates of industrial consumption rate in 1999 would add almost two times more accuracy than the same cost in 2009 on the same parameter. (See figure 11)

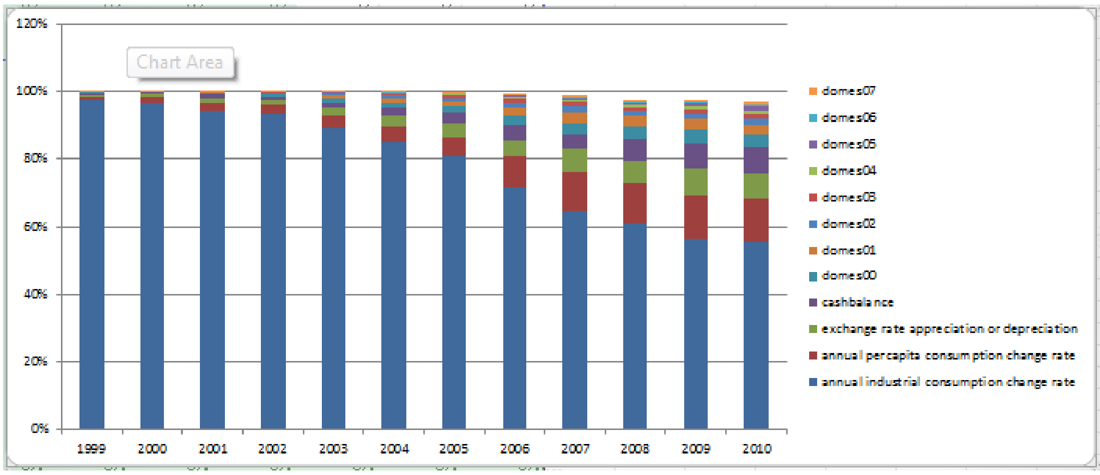

Figure 27: Contribution to variance of equity holder's NPV

5.2.2.2 Banker's point of view

As the last type of cash flow, this profile reveals the performance of the project when considered in the context of the existing structure and without any financial contribution from owners.

The results of simulation shows that the mean NPV of the investment together with current stream of cash from existing facilities would become a fourth of what it could be if the regulation is not adopted. (See table 11 and figure 12)

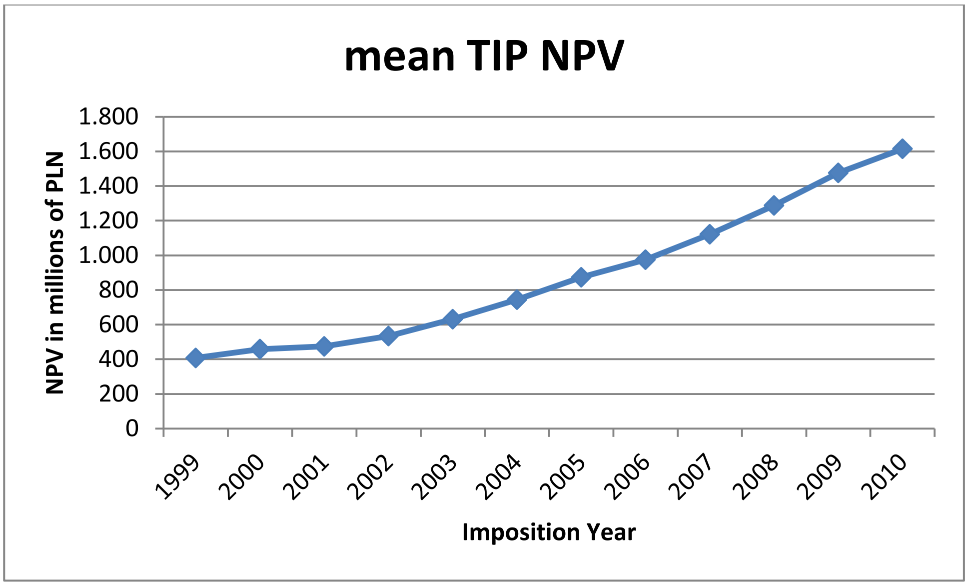

Figure 28: Total investment NPV for different imposition scenarios

This quite serious adverse effect of regulation comes with another considerable but positive consequence. This positive effect is the decrease in the uncertainty surrounding future outcomes. This is shown in the figure 13. The figure demonstrates that the further the adoption of regulation is postponed the higher the standard deviation becomes.

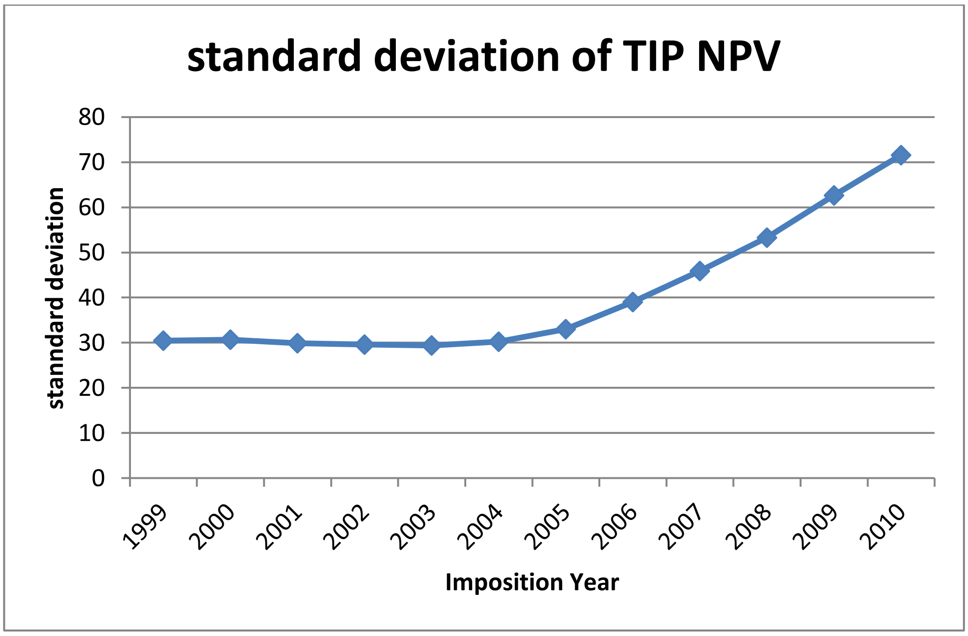

Figure 29: Standard deviation of total investmetn NPV

The figure 14 depicts cost of risk reduction against different years of adoption to show how price efficiency of risk reduction changes. Namely, if the decision maker was trying to assess the price at which the risk is reduced they would rather prefer to impose the regulation sooner because as the figure 14 shows, a one unit reduction of standard deviation in 1999 come with a price equal to 35000 PLN loss of NPV but if it is adopted in 2010 the price will become 65000 PLN for each reduced standard deviation. From the owner's perspective it can act as mean to support the decisions regarding the risk investment strategy of company.

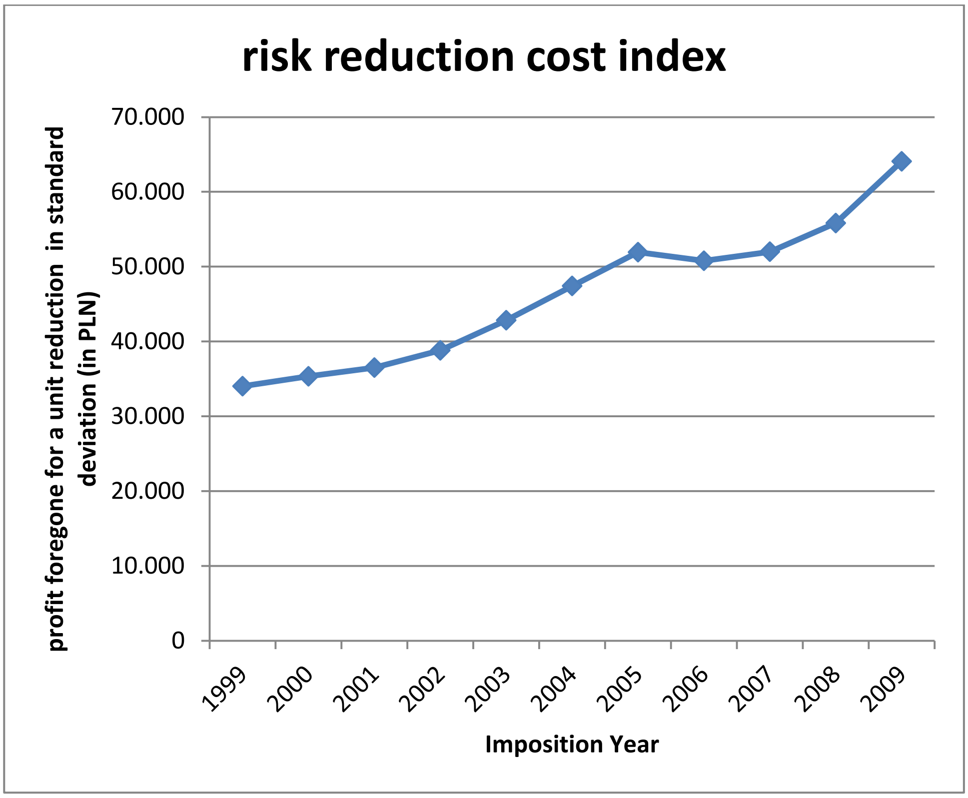

Figure 30: Risk reduction cost index for total investmetn

Table 10: Main statistical indicators of Total investment NPV

Main statistical indicators of Total Real TIP NPV												
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Trials	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
Mean	407.52	458.80	474.31	534.10	631.34	744.00	873.34	974.91	1,121.76	1,288.09	1,476.12	1,615.40
Median	404.31	455.57	471.03	530.86	628.51	742.50	871.89	974.25	1,120.65	1,287.46	1,476.42	1,615.29
Standard Deviation	30.48	30.70	29.92	29.61	29.42	30.25	33.03	39.04	45.90	53.30	62.65	71.57
Variance	928.80	942.30	895.03	876.67	865.34	914.96	1,091.22	1,524.40	2,107.00	2,840.88	3,924.74	5,122.65
Skewness	0.3756	0.3634	0.3885	0.3822	0.3629	0.2330	0.1603	0.1138	0.1108	0.0583	0.0443	0.0510
Kurtosis	2.64	2.59	2.53	2.56	2.68	2.80	2.94	2.92	2.91	2.95	2.92	2.98
Coeff. of Variability	0.0748	0.0669	0.0631	0.0554	0.0466	0.0407	0.0378	0.0400	0.0409	0.0414	0.0424	0.0443
Minimum	318.61	377.72	403.69	456.27	549.93	644.96	741.45	831.26	964.20	1,102.40	1,232.73	1,348.54
Maximum	511.14	566.13	583.16	646.18	741.06	851.37	1,008.29	1,168.21	1,289.67	1,489.04	1,718.82	1,873.02
Range Width	192.54	188.41	179.47	189.91	191.13	206.40	266.84	336.95	325.46	386.63	486.09	524.48
Mean Std. Error	0.30	0.31	0.30	0.30	0.29	0.30	0.33	0.39	0.46	0.53	0.63	0.72
cost of risk reduction index	34024	35341	36505	38809	42839	47423	51936	50788	52003	55828	64082	

`The table of contribution to variance demonstrates (table 12) that the regulation exerts its most extensive influence in terms of reduction of number of critical factors, on this cash flow, i.e. there would be 14 more critical parameters if regulation is not adopted.

The accumulation of share of contribution to variance also has the highest rate relative to other cash flow profiles. This effect is depicted in figure 15.

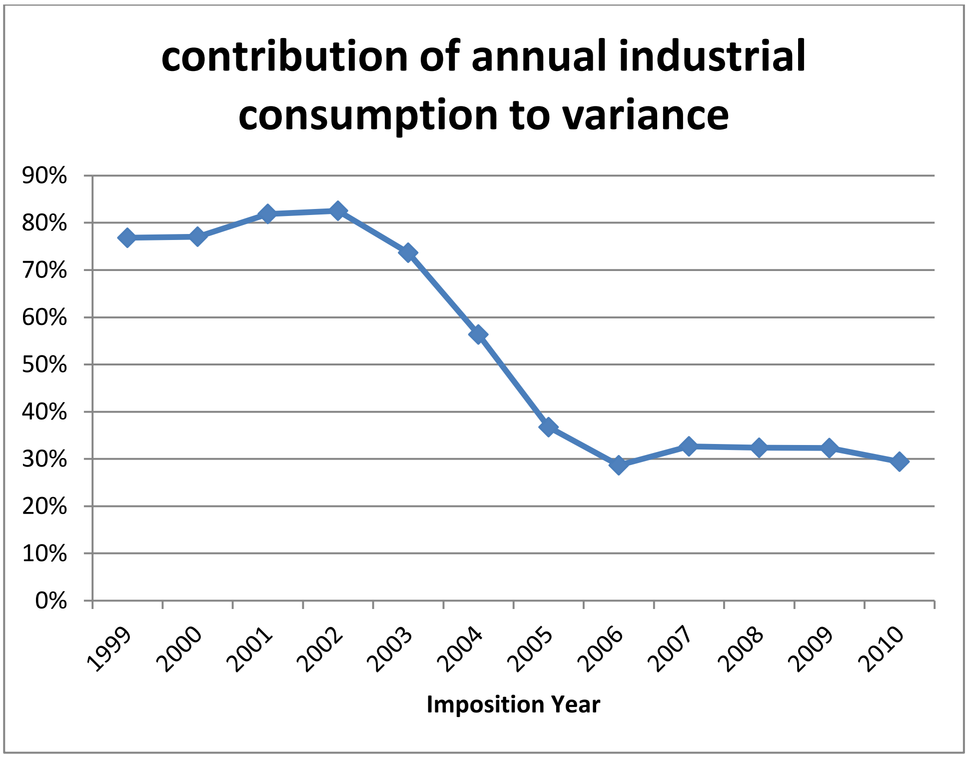

Figure 31: Annual industrial consumption's variance

Table 21: Contribution to variance of total investment NPV

Contribution to Variance of Total Real TIP NPV												
Imposition Year	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
annual industrial consumption change rate	77%	77%	82%	83%	74%	56%	37%	29%	33%	32%	32%	29%
annual percapita consumption change rate	12%	13%	8%	5%	9%	16%	26%	24%	20%	21%	20%	20%
exchange rate appreciation or depreciation	6%	6%	6%	5%	5%	8%	14%	17%	13%	16%	19%	18%
cashbalance	5%	4%	4%	3%	3%	6%	7%	10%	11%	11%	11%	11%
domes00	0%	0%	0%	3%	3%	3%	6%	7%	11%	4%	3%	6%
domes01	0%	0%	0%	1%	2%	3%	5%	5%	3%	3%	2%	3%
domes02	0%	0%	0%	0%	1%	3%	2%	2%	2%	2%	2%	2%
domes03	0%	0%	0%	0%	1%	2%	1%	1%	1%	2%	1%	1%
domes04	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%
domes05	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%	1%	1%
domes06	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%
domes07	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	1%
domes08	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%
domes09	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%
domes10	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%
domes99	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
indus00	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%
indus01	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
indus02	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
indus03	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus04	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus05	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus06	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus07	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus08	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus09	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus10	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
indus99	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
LIBOR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
payable_lag	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
power_growth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
receiv_lag	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
wage_growth	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
WIBOR	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

5.3 Summary of Results

In this research the consistency of the results and reasons behind any conflicts is a major issue because the same project is analyzed from two points of view and through two different approaches.

As the results of the simulation reveals, the way that project is affected by the regulation has three aspects which are the reduction of NPV, reduction of uncertainty surrounding the anticipated outcomes and change in the number of influential parameters.

The effects are summarized as follows:

- The NPV has been reduced in all four points of view that ranges from 17% to 80%

- The standard deviation as the indicator of uncertainty has also been reduced

- The number of influential factors has been reduced except in incremental equity holder point of view. The justification for this insensitivity has been extensively provided in the text.

- The regulation not only renders the sensitivity but also causes a concentration of significance in one of the remaining parameters.

Chapter 6

CONCLUSION

6.1 Introduction

The prospect of adopting new regulations or amending to existing regulations forces the current or prospective owners and operators of water distribution networks to thoroughly assess the impacts that such an intervention from decision makers side could have on financial stance of investment.

In this chapter the implication of such changes in regulation is discussed and plausible measures that could be taken as result of performing this assessment are put forward. In the last part a list of recommendation for further researches is presented.

6.2 Conclusion

The NPV reducing effect of the regulation is the most important and obvious consequence of imposition of the new method of tariff calculation. This will force the investors to take required measures to prevent or at least control the adverse effects of new regulation.

Given the financially non-profitable nature of water distribution projects and their high economic return to society (see Eropean Commission, DG Regional Policy, 2006) the governemts are thoes who should render such investments appealing to the private sector through different tax exeption, grants, in kind concessions etc.

Hence, the investors may ask for different grants, exemptions, provision of annula subcidies that garanty a minimum return on investmetn or other contractual cluases that indexes the profit margin of the investor to the annual return of the investmnet to prevent the infliction of such damages from adoption of regulation.

The other approach to avoid such problem could be restructuring the investment structure to lower the cost of capital and increasing the amount of cheaper capital.

The other consequence of the new regulation is the reduction of uncertainty of investment performance indicators which is the due to inclusion of uncertain parameters in the calculation of tariff. By the way of explanation, such reduction of uncertainty is a result of change in the formulation of financial model rather than better estimation of uncertain inputs.

Having a much certain and accurate idea of future incomes and expenses offers many benefits to stakeholders. The involved parties of the project should make the best use of this impact of the regulation which helps them to draw a more vivid picture of the future.

Expression of cost of risk reduction as a fraction of change in uncertainty divided by change in returns shows the profit foregone for a unit reduction of uncertainty. From policy makers point of view this indicator can act as a measure to compare different alternatives of intervention. From owners or operators point of view this indicator can help them when risk related planning for multiple projects. In other words, because risk reduction cost is much like a future sunk cost, it cannot be evaded or substituted but in conjunction with other parallel projects can have valuable contribution to the decision process of risk investment of a portfolio of projects.

This increase in accuracy of estimations leads to many benefits like reduction in insurance, interest, less risk related expenses and the participation of much more risk averse parties that otherwise would not accept such contributions. Dou to predictability of future, the parties involved can build different scenarios much effectively and consequently manage any contingent accident with better preparedness.

One of the main issues in preparing the assumption of risk analysis of this project is the political factor and because tariff adjustment assumption were estimated only based on then available data and legislative situation, the considerable role of politics in estimation of tariff adjustment coefficients is easily predictable. The influence of political factors must have been much bigger than the role this factor plays now after the introduction of Act on Collective Water Supply and Sewage Collection. This reduction of influence of politics goes back to 1990 when the prices were set centrally and after start of decentralization process this responsibility transferred to local administration (Kommunalkredit Public Consulting, 2009). The final change came after introduction of Act on Collective Water Supply and Sewage Collection according to which the prices have to be prepared based on full cost recovery method (Kommunalkredit Public Consulting, 2009). The extent of sensitivity-reducing effect of regulation is conceivable from contribution to variance tables, where the fading roles of tariff adjustment coefficients are revealed. Consequently, as this sensitivity fades away the role of politics is also becoming paler.

Elimination of such factors from risk analysis process means an increase in the accuracy of analysis and also no more need to speculate on issues that are more of political nature than a function of economic or market principals. However according to Fitch Ratings report the political factor's influence is remaining especially because of need of tariff approval by city council.

6.3 Further Recommendations

For further researches with regards to this subject the recommendations are as follows:

- Investigation of other different cases in terms of geography, political context, industry, sizes etc.

- Application of other sensitivity analysis methods in analysis the data and comparison of results.

- Investigation of different risk reducing, allocating or mitigating method and investigating how they can influence the project.

- Application of this methodology to a portfolio of projects rather than single projects.

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