THE POSSIBILITIES OF APPLYING HISTORIC SIMULATION FOR ASSESSING THE PROFITABILITY OF INVESTMENTS

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Key words: risk factors, risk assessment methods, simulation.

CONCLUSIONS

The above methods of assessment are based on different methodological and mathematical approaches; therefore, they yield slightly different results, which can be used to complement each other and thus gain a more complex picture about the risk of the investment. Calculating break-even points and sensitivity assessment are simple variance calculation methods with differing frameworks or backgrounds. The basis of decision is NPV, as the break even points of the various factors do not come complete with clearly defined rules and cut-off points for accepting or rejecting an investment. This is especially true for the dynamic payback period, which discriminates against long-term investments. Conclusions about the risk of the investment can be drawn if expected values and critical values show high disparity; this can be used for highlighting the more sensitive risk factors. However, in this case, we do not have a distribution of probability for factors, nor the probability of the occurrence of the critical values, so the use of data is limited. It is worth starting risk assessment with these simple methods of analysis to gain more insight into the underlying processes.

If historic simulation is applied, we gain data for analysis from past figures. The basis for this procedure is sufficient quantity and quality data, which might pose considerable difficulties. On one hand, in the case of Hungary, the recent economic changes break the continuity of the data; on the other hand, it is often almost impossible to collect the necessary minimum of 50-100 figures for a realistic simulation generating the distribution of NPV. Setting the optimal time framework is also crucial: if data reach far back in the past, their applicability for present risk assessment is questionable. If the framework spans too short a period, the representativeness of the figures may be doubted. A frequent criticism of the method questions the approach that using real data from the past implies that the events in the past are likely to repeat, and new patterns are not expected to emerge. On the other hand, an advantage of the method is that it can be considered a complex calculation of variance that enables the analyst to assess possible future scenarios without having to define each and every expectation and prospect for the future. A wide range of mathematical skills is not necessary; therefore, it is easy to use, and the results are readily applicable, and expand on the results gained from more simple calculations aimed at assessing the risk of investments.

All the above methods make an attempt at grabbing and describing risk itself. However, they simply cannot consider that investors may have different approaches to risk, which has a crucial impact on the decision about the

investment. Investors expect benefits and positive outcomes proportionate to the risk undertaken; as a result, they have different sets of priorities for future cash flow. Although this factor does not appear in any of the models, using multiple models for an analysis can provide a wider range of information to be considered for assessing the profitability of an investment.

ABSTRACT

Assessing the risk of investments is a key element of profitability assessments. After a brief theoretical description of the risk factors in the agricultural sector, the input factors of investment profitability assessments will be presented with the help of a case study. In the next step, theoretically risk-free investments and real-life methods considering risks as well will be described in a practical framework; these contribute to the reliability of investment risk assessment. I consider historic simulation as a very important tool. In summary, the method relies on calculating projected probability variables from past data; more specifically, it can be investigated how profitability and especially net present value would have changed had the investment taken place at different times in the past. The results display the probability distribution of the profitability criterion. Finally, results will be compared with data from other similar assessments, and the possibilities and limitations of using the method will be considered as well.

INTRODUCTION

Methods used for assessing the risk of investments can have a significant impact on investment decisions that are usually based on calculating traditional profitability criteria. The methods vary significantly in terms of content and methodology; thus providing a range of different frameworks to assess the risk of investment. Historic simulation, which is in the focus in the present study, is mostly used by corporations in the financial sector; however, by modifying certain factors, it is also suitable for assessing the risk of investments in general and in the agricultural sector (*Odening – Mußhoff, 2001*). The advantage of the method is that there is no need to conduct an analytic assessment of each risk factor; in addition, the method relies on past data, thus inherently considers the risk profile of the investment, therefore, the inclusion of factors based on estimates can be avoided. The study contains the following parts. First, the risk factors important from the point of view of the investigation are overviewed. Then, the methods used for assessing risk are summarised, including the theoretical basis of historic simulation. In the subsequent section, the use and steps of the method, including the analysis of the data, are demonstrated using a specific situation in the agricultural sector, and the results are also compared to the outcome from other methods applied for assessing risk. Finally, the feasibility and usefulness of the method are assessed.

MATERIALS AND METHODS

Risk factors

Risk is defined as the possibility that the expected and actual outcome of our actions may differ. Mathematically speaking, risk is involved if an action or experiment (for example, an investment) has more than one possible outcomes (for example, cash flow might vary). Therefore, an event in the future can rarely be defined as a specific value, it is rather a distribution pattern of probability; and risk enters as an element of stan-

dard deviation. There is a wide range of definitions and classifications regarding the concept of risk. If we consider the decisive risk factors in an assessment of the profitability of investment, there are two major groups: risk factors deriving from the special characteristics of the agricultural sector, and factors emerging as margins or error when the profitability assessment is conducted. Risk assessment is more important for investments into the agricultural sector, as there are more external factors having an impact on the profitability than in any other sectors of economy.

Most importantly, environmental and natural risks (farm area, weather, pests, etc.) limit the possibilities for regrouping resources in time and space; in addition, these characteristics also imply that agricultural production needs more resources than other sectors. Moreover, the economic factors are shaped by price disparity, owing to the insignificant impact producers are able to make on prices, which is an additional risk factor. Therefore, risks following the investment mainly manifest as fluctuations in yield and prices (*Alvincz – Guba, 2003*; *Borszéki, 2003*). Risk appears already in the very first step, as data from the present or past are often inaccurate; the analysed economic situations are complex and complicated, thus often simplified. Even given fixed variables such as prices are considered distorted at times. On the other hand, profitability assessments also include elements of subjective decision-making on the part of the analyst; a case in point is the arbitrary setting of the time horizon. These characteristics reduce the reliability of the assessment. Naturally, in addition, all predictions and expectations of general processes and data are estimates based on suppositions, and inevitably come with a built-in margin of error.

Methods used for considering risk

Due to the limitations described above, it is essential to apply methods that improve reliability and include the assessment of risk. The starting point for assessment is the parameters of risk-free investment. In this case, the cash flow following the investment is discounted using a risk-free interest rate. This interest rate is usually calculated as the net yield rate of short-term or long-term government securities, corrected for the effects of inflation; or as WACC (Weighted-Average-Cost-of-Capital) (*Ulbert, 1994*). The weighted average cost of capital is the weighted average of the expected yield of own and external capital (reflects minimum expected yield). In case risk is involved, the expected value of future cash flow can only be discounted with the risk-free interest rate if the investor is supposedly risk neutral or if only diversifiable risk is attached to the investment. As both of these scenarios are highly unlikely, other methods are necessary for considering risk as well as part of assessing the profitability of investments. Table 1 summarises the relevant methods.

Historic simulation

Out of the above procedures used for assessing profitability of investments, the application of historic simulation is presented in detail. The aim is to determine the net present value of the given investment directly based on the changes in the past values of market variables that usually affect the net present value. This way, the risk profile of the investment can be drawn up. Past empirical data are used to study how profitability would have changed in the past if the investment had been made at different times. The result is a probability distribution curve of the profitability criterion.

Table 1

Profitability assessment methods considering risk

METHOD	DESCRIPTION	
BREAK-EVEN-POINTS	Determining the critical values of input factors; if exceeded or not reached, investor behaviour would change.	*Calculation of variance*
SENSITIVITY ASSESSMENT	Changes in NPV can be analysed based on the different variations in the values of uncertain factors or combination of factors.	
STOCHASTIC SIMULATION	Based on the distribution data of certain input factors, the probability distribution of the profitability criterion is calculated.	*Complex calculation of variance*
HISTORIC SIMULATION	The probability distribution of the profitability criterion is calculated from past data.	
AD-HOC DETERMINED RISK MARKUP	Risk markup can be given for influencing factors, especially in the case of cash flow.	*Risk is considered as a factor within the calculations.*
SECURITY EQUIVALENCE PROCEDURE	Considers the effect of the decision-maker's attitude to personal risk on cash flow.	
RISK ADJUSTED DISCOUNT RATE PROCEDURE	The interest rate used for calculation considers not only the time value of money but also the attitude of the investor to risk.	
DARWING UP SCENARIO VARIATIONS	Pessimistic, expected and optimistic scenarios are drawn up by varying the risk factors.	*Risk and flexibility appear together.*
DECISION TREES	Risk appears as risk markup in the calculations.	
REAL OPTIONS THEORY	There is no need to consider the investor's attitude to risk. Both risk and flexibility appear as explicit decision-making parameters.	

Source: Mußhoff – Hirschauer, 2003

The steps of using historic simulation are the following:

1. Choosing the framework of modelling, including the list of risk factors, such as:

- Market variables with a significant effect on NPV.
- The distinct parts of the investment that can be treated as separate units (with separate cost and yield data).
- NPV of the investment.

It is worthwhile to devote attention to adding detailed market variables.

2. Choosing the object of modelling; in other words, the numerical values of the risk factors. The information database for the assessment is provided by past data of the risk variables. Determining the interval to be taken into consideration is important; it is a key element of decision-making that historic data can only be used meaningfully for the analysis if framework conditions are

comparable, i.e., if there were no significant breakdowns and changes from an economic point of view. The risk factor, once in numerical terms, is a modelling factor. In the present case, this means adding the absolute values of the risk factors into the model, but there is also a possibility to calculate relative changes (*Cremers, 1999*).

3. Modelling: the empirical definition of the distribution of the factors used in the model, based on the historic data.

4. Determining the distribution of the net present value of the investment based on the historic data in the model, if NPV itself is not a factor.

The way NPV is calculated must be the same as the methods used in traditional profitability assessment (spatial and time framework, definition of yield and cost, calculative interest rate).

5. The risk profile of the profitability of the investment is drawn up. The following data are analysed: minimum NPV, maximum NPV, average NPV, standard deviation of NPV.

RESULTS AND DISCUSSION

The above theoretical discussion of the steps of historic simulation is demonstrated step by step, using a specific investment into a project in the field of agriculture. First, the basic data and the plan of the investment are outlined, and then the profitability figures are presented. Next, the risk of profitability will be assessed with the help of historic simulation. Finally, results are compared to calculations of critical values and results from the sensitivity assessment.

Description of the investment

An agricultural corporation is planning to build a granary with nominal capacity of 4000 tons. The aim is to expand storage capacities, so that the company is not forced to sell its cereals at dumping price right after harvest.

Setting up a deterministic investment plan

Investment data

Capacity	4000 tons		
Cost	64,250,000 HUF	Subsidies (not to be repaid) 40%.	
Time framework	10 years		
Calculative interest rate	13.19% (WACC)		
Maintenance costs		***Start***	***1st to 10th year***
	Direct	1,282,160 HUF	2,565,000 HUF
	Indirect	174,860 HUF	349,800 HUF
Income[1]		***Start***	***1st to 10th year***
	Cereals	5% of procurement price	5% of procurement price
	Corn	–	10% of procurement price
Company tax	16%		

Calculations of factors of the profitability of investment

NPV	7758,480 HUF
IRR	18%
BCR_1 and BCR_2	1.28 and 1.40
Dynamic payback period	8 years

[1] 2005 procurement prices were used for the calculations (cereals: 20,500 HUF/ton, corn: 20,900 HUF/ton).

In summary, an investment can be considered profitable if the following conditions are satisfied:

NPV > 0

IRR > calculative interest rate

BCR > 1

The investment satisfies these criteria. The NPV has a crucial role: this is the factor to look at for a well-founded decision on acceptance or refusal. The other factors provide supplementary, but important, information. In the next step, the assessment will also include the factor of risk.

Risk assessment of the investment

Applying historic simulation

1. Listing risk factors

Type of risk	Risk factor
Price risk	Price of cereals
	Price of corn
	Yield of own capital
Quantity risk	Cereal and corn yields
	Time span

The main risk factor in the model is the changes in the price of cereals and corn, and the resulting income.

2. Quantifying the risk factor

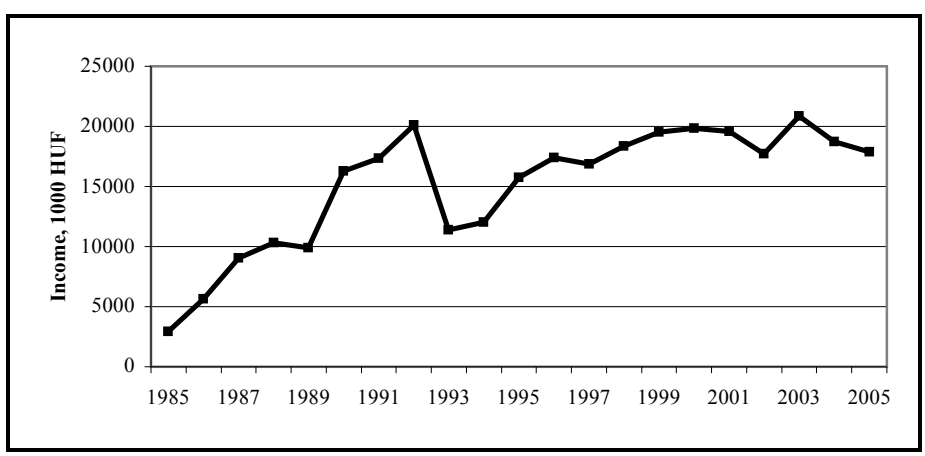
Annual income is calculated as the profit on procurement prices, which amounts to 5% of the procurement price in the case of cereals, and 10% for corn. However, procurement data in Hungary do not qualify for data to be used in this simulation, as they do not meet the requirements about undisturbed economic conditions. Hungarian economy, including the procurement prices, has been affected significantly by the accession to the European Union. Therefore, average procurement prices for the EU-15 countries, as summarised by Eurostat, were used for the calculations. Prices are included in the database since 1971; however, the necessary exchange rates only appear from 1985. Thus, price and income data available for analysis are very limited, which affects the representativeness of the calculations.

3. The distribution of incomes, based on available past data on prices and incomes.

4. Determining the NPV distribution of the investment, drawing up the risk profile.

Figure 1

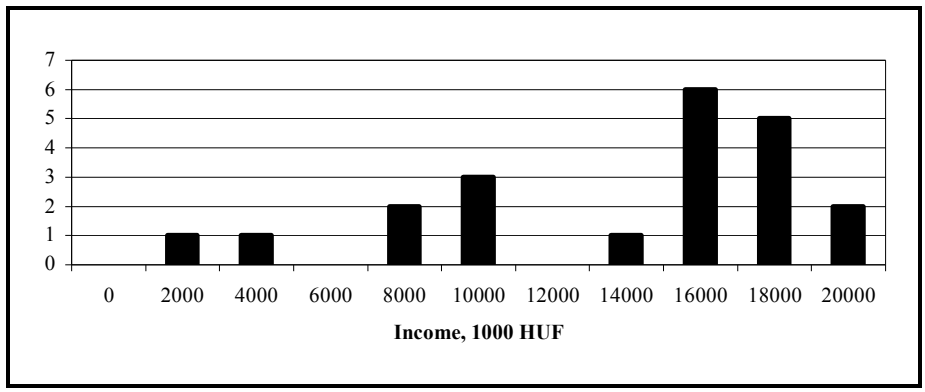
Income 1985-2005



Source: Eurostat

Figure 2

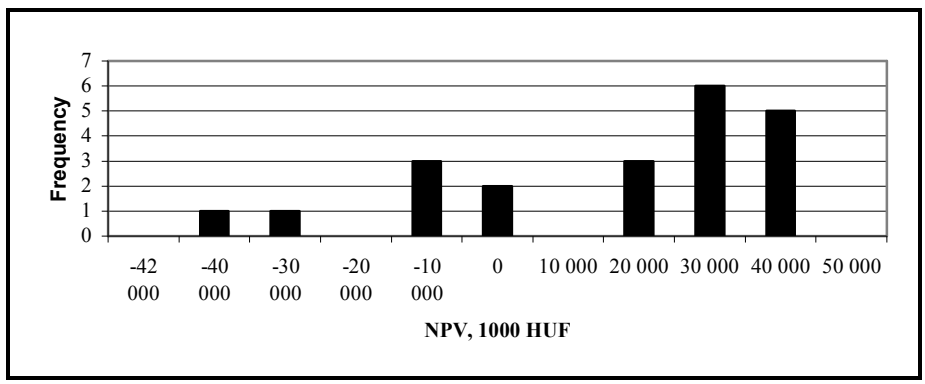
Distribution of income



Source: own calculation

Figure 3

Distribution of the NPV of the investment



Source: own calculation

min. NPV	-37,610.6	NPV mean	+20,653.2
max. NPV	+47,710.5	NPV standard deviation	24365.947

Income values suggest the potential NPV in the past if the investment had been made in the past (1985-2005). Figure 3 suggests that in the majority of cases, the NPV of the investment is definitely positive. NPV displays large standard deviation; however, the mean exceeds the deterministic NPV significantly, from which it can be concluded that the profitability of the investment is certain, provided that tendencies in the past continue.

Calculating critical values (break even points). Break even points were determined for the input factors of the profitability assessment. In case these are exceeded or not reached, investor attitude is expected to change. The most important critical point is a zero NPV (Table 2).

Table 2

Break even points of the risk factors

Risk factor	Supposition	Critical value	Maximum allowed difference
Price of cereals	20,500 HUF/ton	13,275 HUF/ton	-35.24%
Price of corn	20,900 HUF/ton	16,612.5 HUF/ton	-20.54%
Yield of own capital	15.4 %	22.88 %	+148.57%
Production yield	4000 tons	3481 tons	-12.97%
Time span	10 years	8 years	-20.00%

Source: own calculation

It is important to underline the significance of changes in the price and yield of corn. A change in the production volume and yield is not a high-risk element, despite the sensitive reaction of the NPV to even the slightest change. The reason is that the company can compensate for reduced yield by purchasing at procurement price after harvest. The price of corn is the factor with the highest risk. Besides the above, it is important to consider the internal rate of profitability, as this is the interest rate at which the NPV of the investment will be exactly zero. If the interest rate is moving between the internal interest rate and the interest rate reflecting the minimum expected yield, then the NPV of the investment will certainly be positive; therefore, the relative gap between the two figures can provide important insights into the risk of the investment. In the present case, the gap between 18% and 13.19% reflects risky profitability.

Sensitivity assessment. A sensitivity assessment can be conducted by considering the different variations of uncertain variables or combinations of variables. Changes in the target graph, especially the NPV, can be plotted. Modifying the income and cost present values, Table 3 displays the critical range of NPV.

Table 3

Results of the sensitivity assessment

Income / Operation costs	-50%	-40%	-30%	-20%	-10%	0%	10%	20%	30%	40%	50%
-50%	-19,264	-20,980	-22,695	-24,411	-26,126	-27,842	-29,557	-31,273	-32,988	-34,704	-36,419
-40%	-12,144	-13,860	-15,575	-17,291	-19,006	-20,722	-22,437	-24,153	-25,868	-27,584	-29,299
-30%	-5,024	-6,740	-8,455	-10,171	-11,886	-13,602	-15,317	-17,033	-18,748	-20,464	-22,179
-20%	2,096	380	-1,335	-3,051	-4,766	-6,482	-8,197	-9,913	-11,628	-13,344	-15,059
-10%	9,216	7,500	5,785	4,069	2,354	638	-1,077	-2,793	-4,508	-6,224	-7,939
0%	16,336	14,620	12,905	11,189	9,474	7,758	6,043	4,327	2,612	896	-819

Source: own calculation

The majority of negative NPVs are found in the quarter with decreasing income or decreasing income and increasing operation costs; consequently, NPV is income-sensitive. If income decreases by 20%, not even a 30% decrease of maintenance costs can compensate. The table shows that the NPV of the investment is not significantly affected by changes in the operation costs; however, income changes are essential to keeping the delicate balance. In other words, price fluctuations on the market can have a serious consequence on the profitability of the investment. Comparing the results of the three different risk assessment procedures, it is concluded that changes in income have a profound effect on the profitability of the investment; therefore, price changes, and most importantly, changes in the price of corn are high-risk factors. Results from the historic simulation, however, suggest that based on past tendencies, NPV is not necessarily negatively affected by price changes, so the profitability of the investment ha slow risk.

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