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RYZYKO INWESTYCYJNE
RISK IN INWESTMENT APPRAISAL

ROZWÓJ TECHNOLOGICZNY I EKSPANSJA BIZNESU W GRECJI
TECHNOLOGICAL DEVELOPMENT AND BUSINESS EXPANSION

SYSTEM FINANSOWY MŚP W POLSCE
FINANCIAL SYSTEM OF SME SECTOR IN POLAND

POLSKIE REFORMY EKONOMICZNE
POLISH ECONOMIC REFORMS

EKONOMICZNE KONSEKWENCJE UPADKU SOCJALIZMU
ECONOMIC CONSEQUENCES OF THE FALL OF SOCIALISM

WYŻSZA SZKOŁA KUPIECKA
z siedzibą w Zgierzu

Wydawnictwa Naukowe Wyższej Szkoły Kupieckiej

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RISK IN INVESTMENT APPRAISAL

1.Introduction

One of the most important decision-making areas in enterprises is in choosing between possible investment projects in real assets. Since all these problems are about the future none of the input data for decisions is known with absolute certainty and risk is a constant problem to decision makers. Since investors and creditors are risk averse it is necessary for management to incorporate the risk of an investment proposal into their analysis of the proposal's worth.

The present paper introduces the problem of incorporating risk into the capital budgeting decision. In the first part we try to definy what certainty, uncertainty and risk are. In the second part of the paper the components of risk are presented. Next, we examine the simulation, sensivity analysis, probability tree, the certainty equivalent method and risk-adjusted discount rates as main methods for incorporating risk into capital budgeting.

2. Certainty, uncertainty and risk

Certainty is characterized by complete information about each course of action, and the advance knowledge that each alternative has a unique outcome. Uncertainty and risk are characterized by imperfect knowledge about each alternative, and the expectation that each alternative has two or more possible outcomes. There is one important difference between uncertainly and risk. Risk may be define as the phenomenon which arises from circumstances where we are able to identify the possible outcomes and even their like hood of occurrence without being sure which will actually occur. Uncertainly describes the position where we are not able to identify all the possible outcomes and still less able to assess their like hood of occurrence. Other words, we may say that if the investor knows the frequency distribution (probabilities) of possible outcome, he is faced

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with a risky situation. In contrast uncertainly exists when the event is not replicable, thus making the situation unique.

3. Main components of total risk

The total risk associated with an investment is composed of two elements:
1. Systematic risk, which is that portion of total risk attributes to the movement of the market as whole.
2. Unsystematic risk, which is the residual risk that is unique to a specific area.

Systematic risk is attributable to the common economic factor, say overall economic conditions, that affects all assets in the economy in a similar manner. Such factors would include the general level of demand in the economy, interest rates, inflation rates, labour costs. This type of risk cannot be diversified away through asset combinations, because it is the risk that remains after all possible diversification has taken place.

Unsystematic risk is unique or idiosyncratic to the individual asset under consideration by management. This type of risk can be almost completely eliminated through judicious combinations that achieve diversification of assets. This kind of risk is also called specific risk.

We may illustrate this in figure below:

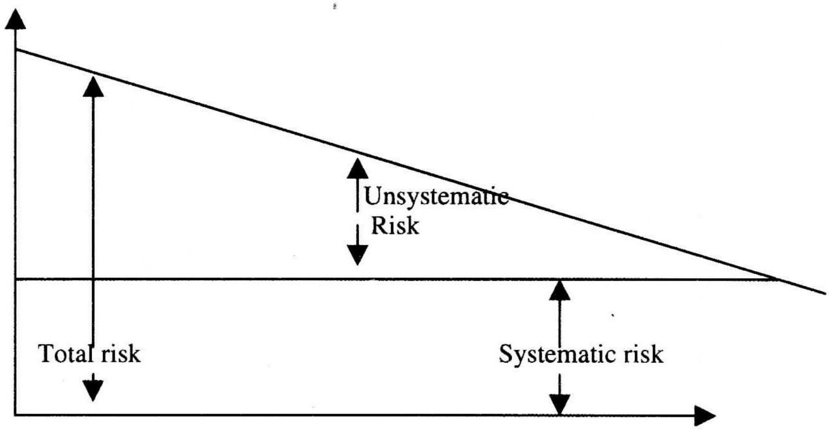


Figure 1 : Relationship of total, systematic, and unsystematic risk

Total risk = Systematic risk (nondiversifiable or unavoidable) + Unsystematic risk (diversifiable or avoidable

It seems to be useful to classify also total risk as follows:

1. Economic risk which reflects risks of the overall economic environment in which the enterprise operates including general economic risk (fluctuactions in business activity), capital market risk (including changes in interest rates), and purchasing power risk.
2. Business risk (or operating risk) is concerned with the ever present uncertainty regarding a business enterprise's ability to earn a satisfactory return on its investments as well as with the multitude of cost and revenue factors that enter into the determination of such a return. It includes the factors of competition, product mix, changes in consumer preferences, prices of factor inputs, labour strikes and management ability.
3. Financial risk is concerned with capital structure and with the ability of an enterprise to meet fixed and senior charges and claims.
4. Approaches for dealing with risk

In this part of the paper we present some approaches for dealing with risk in capital budgeting : simulation, sensivity analysis, probability trees.

4.1. Simulation Approach

In considering risky investments a simulation can be use to approximate the expected value of net present value (NPV) the expected value of internal rate of return (IRR) or the expected value of probability index (PI) and the dispersion about the expected value. A simulation means testing the possible results of an investment proposal before it is accepted. The testing itself is based on a model coupled with probabilistic information. Making use of a simulation model first proposed by David Hertz, we may consider for example, the following factors in deriving a project's cash-flow stream. [Hertz, pp. 95-106]

Market analysis

1. Market size
2. Selling price
3. Market growth rate
4. Share of market (which controls physical sales volume)

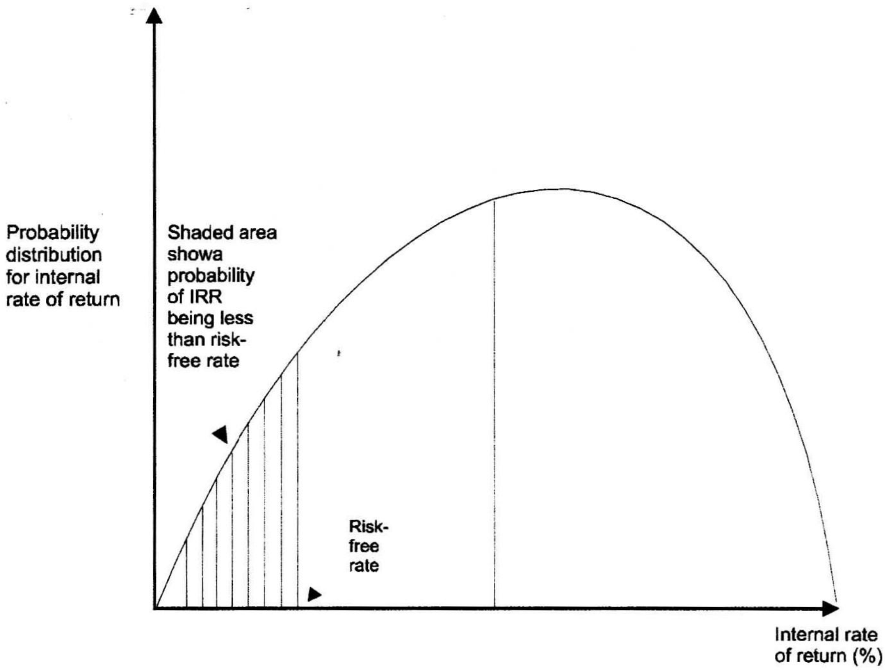
Investment cost analysis

5. Investment required
6. Useful life of facilities
7. Residual value of investment

Operating and fixed costs

8. Operating costs
9. Fixed costs

Probability distributions are assigned to each of these factors based on management's assessment of the probable outcomes. Thus the possible outcomes are carted for each factor according to their probability of occurrence .Once the probability distribution are determined the next step is to determine the internal rate of return (or net present value calculated at the risk – free rate)that will result from a random combination of the nine factors listed above. As a result the internal rate of return (or NPV or PI) can be plotted in a frequency distribution like that shown in figure 2 below. From this frequency distribution the decision maker are able to identify the expected value of internal rate of return (or NPV or PI) and the dispersion about the expected return. The project is accepted if the decision maker feels that enough of the distribution lies above the normal cutoff



criteria (NPV>=0, IRR >=required rate return).

Figure 2 : Output from simulation

Although a simulation appeal as a highly sophisticated, technologically advanced tool for evaluating project risk it is also a controversial technique. One major stumbling block to simulation analysis is that the more realistic the simulation is the more complex it will turn out to be in practice. This is clearly shown in the case of interdepedencies among the variables. The second problem is that in this method there is no clear – cut decision rule.

4.2. Sensitivity analysis

Sensitivity analysis involves determining how the distribution of possible net present value (NPV) or internal rate of return (IRR) or probability index (PI) for a particular project is affected by a change in one particular input value. This is done by changing the value of one input variable while holding all other input variables constant. The distribution of possible NPV, IRR or PI that is generated is then compared with the distribution of possible return generated before the change was made to determine the effect of the change. For this reason sensitivity analysis is commonly called " What if ? Analysis"

By modifying assumptions made about the value and ranges of the input factors management can determine how sensitive the outcome of the project is to these changes.

Sensitivity analysis is a type of breakeven analysis where in respect of each factor it is possibly assess the breakeven point and the margin of safety. Irrespective of the depth to which sensitivity analysis is taken, it enables the decision makers to see which are the crucial estimates and get a feel for its riskiness.

Sensitivity analysis is a valuable technique for project risk analysis and as such it is widely used by business. Despite this sensitivity analysis does have its limitations. Even if a project is very sensitive to changes in a particular variables that variable may be very unlikely to change. Sensitivity analysis however ignore probabilities. In addition it focuses on the effect of variations in one key parameter at a time instead of studying the effect on the project of simultaneous changes in several key variables.

4.3. Probability tree

A probability tree is a graphic exposition of the sequence of possible outcomes it presents the decision maker with a schematic representation of the problem in which all possible outcomes are pictured.

Table 1 shows a tabular illustration of a probability tree for a two years project.

As we can see from table above during the first year there are three possible alternatives. Each of these three possible alternatives is represented as one of the three possible branches. In a similar manner we continue drawing branches during the second year so that each of the possible outcomes is represented by a new branches. The probabilities associated with each outcome are called conditional probabilities because they can occur only if outcome 1 occurs during the first year.

In ascribing probabilities to various aspects, decision makers might use:

1. Objective probabilities based on past experience of the outcomes and their likelihood of occurrence.
2. Subjective probabilities based on opinions preferably of experts, on the possibilities and on their probability of occurrence.

The probability tree allows the manager to quickly visualize the possible future events, their probabilities, and their outcomes. In additional, the calculation of the expected internal rate of return and enumeration of the distribution should aid the financial manager in determining the risk level of the project.

Table 1 : Tabular illustration of a probability tree (initial investment at time 0=240 $)

Year 1		Year 2		
Initial probability P(1)	Net cash flow	Conditional probability P (2/1)	Net cash flow	Joint probability P (1, 2)
		.40	800$	.10
.25	$500	.40	500$	.10
		.20	200$	.05
		1.00		
		.20	500$	.10
.50	$500	.60	200$	.30
		.20	-100$	.10
		1.00		
		.40	800$	.10
.25	$500	.40	500$	.10
		.20	200$	.05
		1.00		

5. Risk-Adjustment Techniques

The approaches presented so far do not provide a straightforward basis for evaluation risky projects. Two major risk – adjustment techniques use the net present value decision method as a base. The NPV decision rule of accepting only those projects with NPV > = 0 will continue to be hold. It must be notice that the initial investment which occurs at time zero is known with certainty and only the present value of cash inflows embodies risk. There are two opportunities to adjust the present value of cash inflows for risk exist:

1/. the cash inflows themselves can be adjusted (certainty equivalents), or

2/. the discount rate can be adjusted (risk – adjusted discount rate)

Certainty equivalents are theoretically superior to risk-adjusted discount rates for project risk investment. However due to the complexity of developing certainty equivalents, risk-adjusted discount rates are most often used in practice .Their popularity stems from two major facts: (1) they are consistent with the general disposition of financial decision makers toward rates of return, and (2) they are easily estimated and applied to risky decision situations.

5.1. Certainty equivalent

The certainty equivalents represent the percent of estimated cash inflow that investors would be satisfied to receive for certain rather than the cash inflows that are possible for each year. The project under consideration is there for adjusted for risk by first converting the expected cash inflows to certain amounts using the certainty equivalents and then discounting the cash inflows at the risk – free rate. The risk-free is the rate of return one would earn on a virtually riskless investment. In means that this method is implemented by converting each expected cash flow into its certainty equivalent, by using a conversion factor that can range from 0 to 1.0. Specifically the expected cash flow for period t CF t is multiplied by the conversion factor for period t, at, and the resulting number, a^t CF^t, is the certainty – equivalent cash flow. The 1.0 the value of a^t will be. Equivalently a high a^t implies a more certain and their for, more valuable expected cash flow. Less certain cash flows are valued less highly and accordingly have lower conversion factors.

The certainty – equivalent conversion factors are calculated as follows:

a_t =certain cash flow / Expected cash flow

The certainty equivalent cash flows a_t CFt are then discounted at the risk – free rate of return to yield a certainty equivalent net present value as follows:

$$\text{Certainty – equivalent NPV} = -a_0 I_0 + \sum_{t=1}^{n} a_t \; CF_t / (1+r_f)^t$$

Where:

a_o – certainty – equivalent conversion factor associated with the initial investment I_o at time 0

a_t – certainty – equivalent conversion factor associated with the net cash flow CF_t at time t

N – expected life of the project

r_f - -risk free rate

5.2. Risk – Adjusted Discount Rate

A more practical approach to risk adjustment involves the use of risk – adjusted discount rates. The risk – adjusted discount rate reflects the return that must be earned on the given project to compensate the firm's owners adequately thereby resulting in the maintenance or improvement of share price. The higher the risk of the project the higher the risk adjusted discount rate. (and therefore the lower the net present value for a given steam of cash inflows). Then the normal capital – budgeting criteria are applied expect in the case of the internal rate return. For the IRR the hurtle rate with which the project's internal rate of return is compared now becomes the risk adjusted discount rate. Expressed mathematically, the net present value using the risk –adjusted discount rate becomes

$$NPV = \sum_{t=1}^{n} \frac{ACF\,t}{(1+I^*)^t} - I0$$

Where :

ACF t – the annual after tax expected cash flow in the time period t

IO - the initial cash outlay

i* - the risk adjusted discount rate

n - the project's expected life

Using the coefficient of variation as a measure of project risk the firm can develop some type of market risk – return function – a graph of the discount rates associated with each level of project risk. An example of such a function is given in future 3. The risk return function indicates that project cash inflows associated with a riskless event (coefficient of variation = 0) should be discounted at a 6 percent rate. This rate of return therefore represents the risk – free rate. For all levels of risks greater than certainty (coefficient of variation >0) the associated required rate of return is indicated. Figure 3 is a risk return function which means that investors will discount cash inflows with the given levels of risk at the corresponting rates. Therefore in order not to damage its market value the firm must use the correct discount rate for evaluating a project. If a firm discounts a risky project's cash inflows at too low a rate and accepts the project the firm's market price may drop as investors recognize that the firm itself has become more risky. The amount by which the required discount rate exceeds the risk – free rate is called the risk premium. It of course increases with increasing project risk.

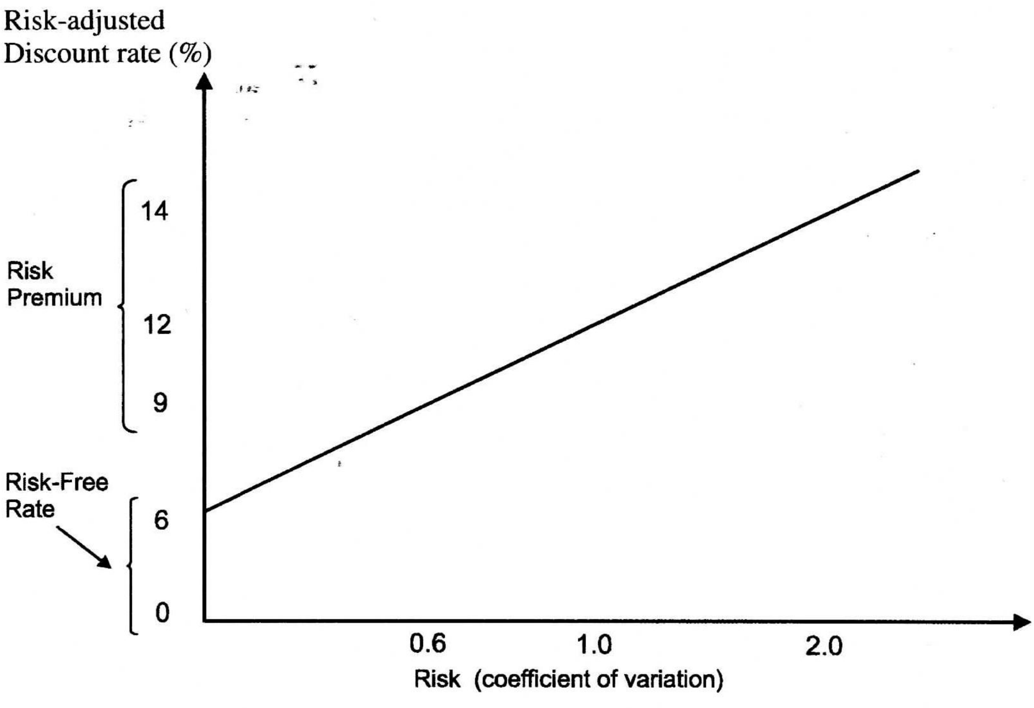


Figure 3 : A Market Risk Return-Function

Summary

A risk may be expressed as the variability of possible returns .Macroeconomic risk factors which affect all firms to a greater or lesser degree, include changes in the growth rate of the economy the inflation rate and the level of real interest rates. Risk factors that are company and project specific include competitor actions shifting consumer tastes technological uncertainty, uncertain exploration costs and changing input costs and output prices. Macroeconomic risk factors are the primary source of systematic risk whereas firm specific risk factors result in unsystematic risk. This paper described some of the methods that firms use to factor risk into their project analyses. These methods include adjusting the discount rate and using certainty equivalent cash flows. The end result of this analyses is the risk adjusted project net present value or internal rate of return or probability index. However many firms also perform sensitivity analyses on project cash flows to appraise the effect on the project net present value of varying the values on certain key parameters. In addition the event of low-cost, high –powered computers and computer modeling techniques has encouraged a number of firms to simulate the effects of changing several of these parameters simultaneously while taking into account the probability of these changes actually occurring. The output from a simulation analysis is a probability distribution of project NPV, IRR or PI. Finally we considered the evaluation of projects in which a sequence of decisions must be made at different time with each subsequent decision being affectes by earlier decisions and the outcomes of those decisions. A useful aid in such situation which is known as probability tree analysis is to graph the alternatives and their possible consequences.

Although none of these techniques for assessing project risk and incorporating risk in a project analysis is perfect some useful information may be gained from each. Employing several techniques in combination is likely to prove the most fruitful approach in practice.

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Abstract

This paper examines various ways in which risk can be incorporated into the capital –budgeting decision. Examples are also given to illustrate each of the proposed techniques. The authors conclude that employing several techniques in combination is likely to prove the most fruitful approach in practice.

Περίληψη

Αντικείμενο του άρθρου που ακολουθεί είναι η μελέτη των διαφόρων μεθόδων που λαμβάνουν υπόψη τον κίνδυνο στη διαδικασία αξιολόγησης επενδυτικών σχεδίων. Δίδονται επίσης παραδείγματα , που απεικονίζουν την κάθε μέθοδο. Οι συγγραφείς συμπεραίνουν ότι μόνο η εφαρμογή ενός συνδυασμού μεθόδων μπορεί να οδηγήσει στη συναγωγή ορθών συμπερασμάτων στην πράξη.