Estimation of Risk Levels for Building Construction Projects

Gabriella Maselli[1(✉)], Antonio Nesticò[1], Gianluigi De Mare[1], Elena Merino Gómez[2], Maria Macchiaroli[3], and Luigi Dolores[1]

[1] Department of Civil Engineering, University of Salerno, Fisciano, SA, Italy
{gmaselli, anestico, gdemare, ldolores}@unisa.it
[2] Nebrija University, Calle Pirineos, 55, 28040 Madrid, Spain
emerino@nebrija.es
[3] Department of Industrial Engineering, University of Salerno, Fisciano, SA, Italy
mmacchiaroli@unisa.it

Abstract. This paper aims to define an innovative method to estimate the investment risk thresholds, in order to provide the analyst with essential terms for the economic evaluation of the projects. The idea is to borrow from the As Low As Reasonably Practicable (ALARP) principle the concepts of the acceptability threshold and tolerability threshold of risk. Following this principle, generally used to assess the risk of human life loss, a risk is ALARP: when the costs for its mitigation appear to be disproportionate to the achievable benefits; that is when it lies between the unacceptable and the broadly acceptable region. To estimate the thresholds of acceptability and tolerability, the theoretical reference is the Capital Asset Pricing Model (CAPM), which enables to compare the investment risk not only to the return of the production sector in which the project under consideration falls, but also to the return of the market as a whole. The combined use of CAPM and statistical survey methods makes it possible to attribute the two risk thresholds to investments in a specific sector. In this paper, the focus is on risk assessment for building construction projects. For this production sector, the proposed analysis model is implemented with reference to official data concerning the Italian economy.

Keywords: Risk assessment · Economic evaluation · ALARP logic · Capital Asset Pricing Model · Building construction projects

1 Introduction

Many factors influence the riskiness of a civil engineering project. First, the difficulty of expressing with certainty forecasts on the critical variables, namely those that significantly influence the value of the economic performance indicators. Secondly, the

G. Maselli, A. Nesticò, G. De Mare, E.M. Gómez, M. Macchiaroli, L. Dolores—The six authors contributed equally to this work.

© Springer Nature Switzerland AG 2020
O. Gervasi et al. (Eds.): ICCSA 2020, LNCS 12251, pp. 836–851, 2020.
https://doi.org/10.1007/978-3-030-58808-3_60

need to consider environmental, social and cultural parameters in assessments, which are often difficult to estimate [1–4]. This leads to having to express the outcome of the Cost-Benefit Analysis (CBA) in stochastic terms. Specifically, investment is risky if the probability that the profitability indicator is lower than a threshold value considered critical is high. The greatest difficulty is precisely estimating these limit levels of risk, not suggested either by the sector literature or by the national and EU regulatory guidelines [5, 6].

Thus, the objective of the paper is to establish limit thresholds useful for assessing the acceptability of investment risk. The idea is to establish the risk thresholds based on the As Low As Reasonably Practicable (ALARP) principle. In accordance with this principle, widely established to assess safety in the industrial environment, a risk is defined as ALARP when the costs for its mitigation appear to be disproportionate to the achievable benefits or, in other words, if it is between the acceptability threshold and tolerability threshold [7–9]. From ALARP, therefore, we take up the concepts of acceptability threshold and tolerability threshold, which respectively represent the limit below which the risk is broadly acceptable and the one above which it is intolerable.

Once these two risk thresholds have been defined, an innovative method is proposed to estimate them. In the financial field, these thresholds correspond to the expected return from an investment project with an "acceptable" and "tolerable" risk profile respectively. For this reason, the Capital Asset Pricing Model (CAPM), which explains how the risk of a financial investment affects its expected return, represents the theoretical reference useful for assessing the acceptability and tolerability of risk [10, 11]. The joint use of the CAPM and statistical survey tools also makes it possible to specify risk limit values depending both on the investment sector and on the territorial context in which the project takes place.

The paper is structured into four sections. Section 2 examines the investment risk assessment in support of the CBA, as suggested by the EU regulatory guidelines. In Sect. 3, the ALARP principle and the CAPM are first exposed, and then the methodology for estimating the acceptability and tolerability thresholds of the investment risk is proposed. In Sect. 4, we implement the proposed method to estimate the acceptance limits of the risk related to building construction investments in the Italian territorial context. In the last section, final reflections are analysed.

2 The Investment Risk in the Building Construction Projects

The European regulatory guidelines highlight the importance of risk analysis in the *ex ante* evaluation of investment projects. In this regard, Regulation no. 1303/2013 of the European Commission specifies that risk analysis can be required either by virtue of the complexity or by virtue of the project size and in relation to the availability of data necessary for the evaluation [12]. In particular, it is mandatory in the case of major projects, defined as «works, activities or services intended in itself to accomplish an indivisible task of a precise economic or technical nature which has clearly identified goals and for which the total eligible cost exceeds € 50 000 000».

The Guide to Cost-Benefit Analysis of investment projects of the European Commission (EC) for the 2014–2020 programming period, on the other hand, identifies four main phases in the risk management process [13]:

1) sensitivity analysis;
2) qualitative risk analysis;
3) probabilistic risk analysis;
4) risk prevention and mitigation.

Phase 1. The CBA allows expressing a judgment on the economic performance of the investment, as well as to choose between alternative projects. This technique consists of: forecasting the costs and benefits that the project initiative generates in the analysis period; in the subsequent discounting of the Cash Flows (CF); therefore in the estimate of the performance indicators, Net Present Value (NPV), Internal Rate of Return (IRR), Benefits/Costs ratio, Payback Period [14–19]. If we consider the IRR as an indicator of economic performance, then:

$$\sum_{t=0}^{n} \frac{B_t - C_t}{(1IRR)^t} = 0 \tag{1}$$

Where B_t e C_t represent respectively the costs and benefits at time t.

In the implementation of the CBA, the sensitivity analysis enables to identify the "critical" variables of the project, namely those that have the greatest impact on the result of the evaluation. The sensitivity analysis is carried out by changing the values associated with each variable and evaluating the effect of this change on the profitability indicators of the project. Considering "critical" the variables for which a variation of $\pm 1\%$ of the value adopted in the base case determines a variation of more than 1% of the value of the economic performance indicator can be a guiding criterion for identifying sensitive variables. To study the impact on the project determined by the simultaneous variation of the critical variables, the sensitivity analysis can be completed with the scenario analysis. The estimation of profitability indicators in optimistic and pessimistic scenarios allows expressing a preliminary judgment on the project risks.

Phase 2. The qualitative risk analysis is substantiated: in: the identification of possible events with negative implications on the execution of the project; the consequent definition of a risk matrix for each adverse event, from which it is possible to read the probability of occurrence (P) and severity of the impact (S); in the interpretation of the risk matrix in order to evaluate the risk levels associated with the project ($P \cdot S$); planning major risk mitigation interventions according to the level of estimated risk.

Phase 3. The probabilistic risk analysis is expressed in the stochastic description of the critical variables of the project and in the subsequent estimate of the probability distribution of the profitability indicator. The transition from the cumulative probability curve of the risky variables to that of the project IRR occurs through the Montecarlo analysis. Briefly, the random extraction of the probable values for each critical variable allows deriving the respective value of the profitability indicator. By repeating the procedure for a sufficiently large number of extractions, the probability distribution of the IRR is derived.

From the reading of the probability distribution of the IRR it is possible to derive important information on the project risk, for example the expected value and the variance of the profitability index E(IRR).

If p(IRR) is a continuous random variable with probability density, the expected value (mean or mathematical expectation) of the variable is defined as the integral extended throughout $\mathbb{R}$ of the product between IRR and the density function p(IRR):

$$E(\text{IRR}) = \int_{-\infty}^{+\infty} \text{IRR} \cdot p(\text{IRR}) \tag{2}$$

Discretizing the probability density function of the IRR, then the expected value of the discrete random variable E(IRR) is the sum of the products between the IRR_i values and the respective probability $p(\text{IRR}_\text{i})$, that is:

$$\text{E}(\text{IRR}) = \sum_{\text{i}=1}^{\text{n}} \text{IRR}_\text{i} \cdot p(\text{IRR}_\text{i}) \tag{3}$$

With n number of discretization intervals of the probability distribution of the random variable IRR.

The comparison between E(IRR) and performance limit values makes it possible to express a judgment on the project risk. In this sense, however, it should be noted that the regulatory guidelines do not provide clear indications on the acceptability levels of the project risk.

Phase 4. The definition of an effective risk mitigation and/or prevention strategy is a direct consequence of the results of the previous phases. This phase includes the selection of mitigation measures; the implementation of the prepared plan; the analysis and evaluation of the residual risk, i.e. the risk that remains despite the mitigation strategy undertaken. In other words, it is necessary to re-estimate the probability distributions of the risky variables of the project, deriving from the implementation of the risk containment measures and, consequently, that of the economic performance indicator.

3 The Investment Risk in the Building Construction Projects

It has already been highlighted that for the "building construction" sector, the literature and regulations do not indicate limit values for the acceptance of investment risk. Thus, the aim of the work is twofold: 1) to establish threshold levels for risk; 2) to define a methodology useful for estimating risk acceptance thresholds that can guide the analyst in the economic evaluation of the projects.

As regards the first objective, the reference is the ALARP principle, summarized in Subsect. 3.1. Specifically, the ALARP principle is based on the concepts of risk acceptability threshold and tolerability threshold. These are respectively the limit value below which the risk is broadly acceptable and the limit value above which the risk is acceptable so that mitigation measures must necessarily be planned.

Instead, to achieve the second objective, we use the Capital Asset Pricing Model (CAPM), described in Subsect. 3.2. The CAPM is the theoretical reference for establishing risk tolerability and acceptability thresholds, as it allows to assess the risk-adjusted discount rate r(β), which can be interpreted as the minimum return expected from an investment project with a β risk profile [10]. The combined use of CAPM and statistical survey methods makes it possible to calibrate the thresholds of acceptability and tolerability of risk to investments in a specific sector, based on a statistically acceptable return on investment (ROI) panel of companies operating in a given territorial context. The use of these tools allows characterizing an innovative method for estimating the acceptability and tolerability thresholds of investment risk, as detailed in Subsect. 3.3.

3.1 Risk Assessment According to ALARP Criteria

The risk assessment is developed in the safety field, that is, to analyse the risk of loss of human life in the performance of dangerous activities. Since 1960, tragic accidents in installations with dangerous substances have demonstrated the need for criteria to judge the tolerability/acceptability of these activities. The first risk acceptance criteria are born in the nuclear field, where even low probability of accidents can have catastrophic consequences [20]. It is in this context that in the 1960s–70s the probabilistic analyses of accidents made the first quantitative risk assessments possible. In 1992, in response to the need to manage industrial risks, the British Agency Health and Safety Executive (HSE) defined general risk acceptance principles [21–23]. Among these, of absolute importance is the As Low As Reasonably Practicable principle, according to which all risk mitigation measures must be implemented as long as the costs do not appear disproportionate to the benefits that can be achieved. An intervention can be defined as "practicable" as long as its technical feasibility is demonstrated, while "reasonableness" implies the need to also consider extra-monetary aspects, that is, social, cultural and environmental aspects. In other words, any risk reduction intervention is ALARP if "reasonably" feasible and sustainable in the broad sense, that is, it is tolerable if further mitigation interventions have costs disproportionate to the achievable benefits. Thus, a risk is ALARP if it lies between the acceptability threshold and the tolerability threshold. Risks that fall below the tolerability threshold must be necessarily reduced because they are unacceptable; those included between the tolerability and acceptability thresholds are in the ALARP area, that is, they must be mitigated up to reasonable practicability; on the other hand, the risks above the acceptability threshold are "broadly acceptable" or it is not necessary to mitigate them [24–26].

The ALARP approach, which originated in the nuclear sector, is increasingly used to plan land use in the immediate vicinity of industries or dams, to manage landslide risk, and to assess risk in tunnels [27–31]. If so far it has been generally applied to assess the security risk associated with the safeguarding of human life, we believe that the ALARP criterion can also be applied again in the assessment of the riskiness of investments in the civil sector. Even in this case, in fact, the main objective is the triangular balance between risk, mitigation costs and achievable benefits.

3.2 The Capital Asset Pricing Model to Evaluate Risky Projects

Sharpe [32] Lintner [33] and Black [34] introduced the Capital Asset Pricing Model into financial economics. This model extends the market portfolio model introduced initially by Markowitz [35] who argue that investors are risk averse investors and will choose a portfolio by trading off between risk and return for one investment period, [36]. The CAPM a static model of portfolio allocation in conditions of uncertainty and risk aversion, which relates the return r_i of the i-*th* investment with the risk-free return r_f and the market return r_m [37–39] according to the formula:

$$E[r_i] = r_f + \beta \cdot \left(E[r_m] - r_f\right) \tag{4}$$

In (4): E is the expectation operator; r_i and r_m respectively represent the gross return on the investment in question and the return on the market portfolio; r_f, on the other hand, is the return referring to a risk-free investment. The difference between the market return and the risk-free return returns the market risk premium, i.e. the remuneration for the risk assumed by the investor. The β coefficient gives a measure of the systematic, i.e. non-diversifiable, risk of a company and expresses the expected percentage change in the excess return on an investment for a 1% change in the excess return on the market portfolio, so if:

- $\beta = 0$, the investment is risk-free and its return is equal to r_f;
- $\beta = 1$, the investment has the same risk as the market and its return is equal to r_m;
- $\beta < 0$, the investment is risky but its risk level moves "against the trend" to the general average;
- $0 < \beta < 1$, the initiative is risky but less than the market and its risk level moves "in the same direction" as the latter;
- $\beta > 1$, the risk level of the project still moves "in the same direction" as the market but is higher than the average [40–44].

In other words, β summarizes how much the investment in question amplifies the risks affecting the global market. In formula:

$$\beta = \frac{\text{cov}\ (r_i, r_m)}{\text{var}\ r_m} \tag{5}$$

In which the numerator is the covariance between return r_i of the generic investment and market return r_m, while the denominator coincides with the variance of the market return r_m.

To test the model, we write the Eq. (4) in the form:

$$r_i = a_o + a_1 \cdot \beta + u_i \tag{6}$$

where:

$a_o = r_{f;}$
$a_1 = E[r_m] - r_{f;}$
r_i = realized return on asset *i* over our sample;
u_i = expectational error = $r_i - E[r_i]$.

It follows that graphically β corresponds to the inclination of the straight line that best interpolates the excess returns of the investment compared to the excess returns of the market [45–47].

3.3 Estimation of Risk Acceptability Threshold

The *acceptability threshold* T_a, which in the safety field is defined as the limit below which the risk is widely acceptable, in the case study it represents the expected return on an investment project whose risk profile represents the average risk profile of construction companies with "worse" returns, statistically those of first quartiles (0–25%). Therefore:

$$r(\beta_a) = T_a = r_f + \beta_a \cdot (r_m - r_f) \tag{7}$$

In (7) r_f is the risk-free rate, estimated as the average yield on 10-year government bonds. β_a is the "acceptable" systematic risk, a function of the return r_I of the first quartile companies and the return r_m of an ideal "market portfolio" made up of the total manufacturing enterprises of a country. β_a is given by the inclination of the line that best interpolates the average excess returns Y_I of the sector companies represented in the first quartile with respect to the average excess returns X of the market. In formula:

$$X = r_m - r_f \tag{8}$$

$$Y_I = r_I - r_f \tag{9}$$

where r_I is the average *Return of Investment* (ROI) of the sector companies belonging to the lower quartile.

3.4 Estimation of Risk Tolerability Threshold

The *tolerability threshold* T_t, which in the safety environment separates the ALARP area from the unacceptable one, coincides with the expected return of the company statistically representative of the second quartile of data (50–75%). So:

$$r(\beta_t) = T_t = r_f + \beta_t \cdot (r_m - r_f) \tag{10}$$

with β_t "tolerable" systematic risk, a function of both the return r_{II} of the second quartile company and the return r_m of the market. β_t coincides with the inclination of the straight line that best interpolates the excess returns Y_{II} of the average company in the sector with respect to the average excess returns X of the market:

$$Y_{II} = r_{II} - r_f \tag{11}$$

with r_{II} equal to the ROI of the average sector company.

4 Construction Building Projects in Italy: Risk Limit Values

The method described in Sect. 3 is implemented to estimate the tolerability and acceptability thresholds of risk for investments in the "building construction" sector (ATECO 41) in Italy. Once the parameters common to (7) and (10), i.e. the risk-free rate r_f and the market return r_m, have been determined, the "acceptable" systemic risk β_a and the "tolerable" systematic risk β_t are estimated, hence the threshold values T_a and T_t.

4.1 Estimation of r_f and r_m

The risk free rate r_f is equal to the average rate of return of the 10-year Treasury bonds (BTP) in the period 2009–2018 (source: Ministry of Economy and Finance, Department of the Treasury). The elaborations return $r_f = 3.44\%$.

The rate of market return r_m is assumed to be equal to the average ROI of the main 2095 Italian manufacturing companies in the decade 2009–2018 (source: Mediobanca Research Office). From the analyses derives $r_m = 7.76\%$.

The risk premium X, given by the difference between r_m and r_f, is 3.32%.

Table 1 shows the estimates of return rate of the market r_m, the risk-free rate r_f and the risk premium X.

Table 1. Estimate of r_m, r_f and X (sources: Ministry of Economy and Finance, Treasury Department; Mediobanca Studies Office).

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Mean
r_f (%)	4.32	4.01	5.25	5.65	4.38	3.00	1.70	1.40	2.14	2.54	**3.44**
r_m (%)	8.10	6.70	8.30	7.30	7.40	7.20	8.40	8.10	7.90	8.20	**7.76**
X (%)											**4.32**

4.2 Estimation of β_a and Acceptability Threshold T_a

The estimation of the systematic risk β_a is necessary to evaluate the acceptability threshold, which separates the ALARP risk region from the "widely acceptable" one. The β_a risk refers to the first quartile Italian companies in the "building construction" sector, which is 25% of the companies studied with the lowest ROI. Therefore, β_a is given by the relationship between two terms: covariance between the return r_I of the first quartile company and the market return r_m; variance of market yield r_m

$$\beta_a = \frac{\text{cov}\ (r_I, r_m)}{\text{var}\ r_m} \tag{12}$$

In a Cartesian plane, β_a corresponds to the inclination of the straight line that best interpolates the average excess returns $Y_I = r_I - r_f$ of the first quartile firms with respect to the average excess returns $X = r_m - r_f$ of the market in the time interval 2009–2018. r_I is estimated as the average ROI of 6949 Italian companies of the first quartile with code ATECO 41. The data are taken from the AIDA database of the Bureau Van Dijk. This database contains financial and commercial information of more than 500,000 companies active on the national territory. The analysis was conducted over a period of only 10 years because the AIDA database provides the values of the financial performance indicators of companies only for the last decade. The elaborations return $\beta_a = 1.26$. The results are summarized in Table 2 and Fig. 1.

The estimate of the determination coefficient R_2 allows evaluating the accuracy of the regression. The value $R^2 = 0.91$ demonstrates a high correlation between the variables. Tables 3 and 4 show the statistical parameters of the regression and the standard error of the terms that make up the regression line, i.e. both the intercept on y and β_a.

Table 2. Estimation of β_a

Year	r_I (%)	r_m (%)	r_f (%)	Y_I (%)	X (%)
2009	1.94	8.10	4.32	−2.38	3.78
2010	2.30	6.70	4.01	−1.71	2.69
2011	2.38	8.30	5.25	−2.87	3.05
2012	2.06	7.30	5.65	−3.59	1.65
2013	1.19	7.40	4.38	−3.19	3.02
2014	2.36	7.20	3.00	−0.64	4.20
2015	3.65	8.40	1.70	1.95	6.70
2016	3.53	8.10	1.40	2.13	6.70
2017	3.76	7.90	2.14	1.62	5.76
2018	4.41	8.20	2.54	1.87	5.66
Mean	2.76	7.76	3.44	−0.68	4.32
COV(X,Y_I)	0.00040064	VAR X	0.000317697	β_a	1.261

4.3 Estimation of β_t and Tolerability Threshold T_t

The tolerability threshold T_t, which separates the ALARP risk region from the unacceptable one, is instead a function of the systematic risk β_t. This risk is associated with the second quartile company in Italy. Thus, β_t corresponds to the slope of the line that best interpolates the average excess returns $Y_{II} = r_{II} - r_f$ of the second quartile company with respect to the average excess returns X of the market:

$$\beta_t = \frac{\text{cov}\,(r_{II}, r_m)}{\text{var}\; r_m} \tag{13}$$

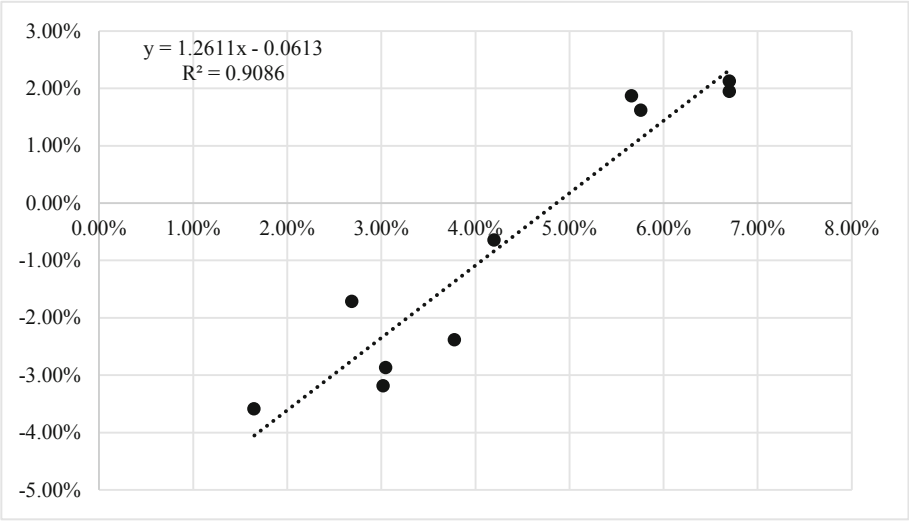

Fig. 1. Regression line for the estimate of β_a.

Table 3. Regression statistics for T_a.

	T_a
R multiple	0.953186
R^2	0.908563
R^2 correct	0.897134
Standard error	0.007563
Observations	10

Table 4. Standard error on β_a and T_a.

	Coefficients	Standard error	Stat t	Significance value	Lower 95%	Higher 95%
T_a	−0.06131	0.006563	−9.34119	1.41E−05	−0.07644	−0.04617
β_a	1.261077	0.141442	8.915839	1.99E−05	0.934911	1.587244

Where r_{II} equals the average ROI of companies with code ATECO 41 of the second quartile. Also for the estimate of β_t the ROI values of the Italian companies of the last decade were used, because they are the only values provided by the AIDA database.

The elaborations, summarized in Table 5 and Fig. 2, return $\beta_t = 0.84$.

Tables 6 and 7 show the statistical parameters of the regression and the standard error of the terms that make up the regression line, i.e. both the intercept on y and the β_t. For the β_t estimation, the analyses reveal a high correlation between the variables, with a value of R^2 equal to 0.93.

Table 5. Estimation of β_t.

Year	r_{II} (%)	r_m (%)	r_f (%)	Y_{II} (%)	X (%)
2009	6.77	8.10	4.32	2.45	3.78
2010	6.20	6.70	4.01	2.19	2.69
2011	6.31	8.30	5.25	1.06	3.05
2012	5.68	7.30	5.65	0.03	1.65
2013	5.79	7.40	4.38	1.41	3.02
2014	5.73	7.20	3.00	2.73	4.20
2015	5.98	8.40	1.70	4.28	6.70
2016	6.08	8.10	1.40	4.68	6.70
2017	6.14	7.90	2.14	4.00	5.76
2018	6.55	8.20	2.54	4.01	5.66
Mean	6.77%	7.76	3.44	2.45	4.32
COV(X,Y_{II})	0.000266225	VAR X	0.000317697	β_a	0.838

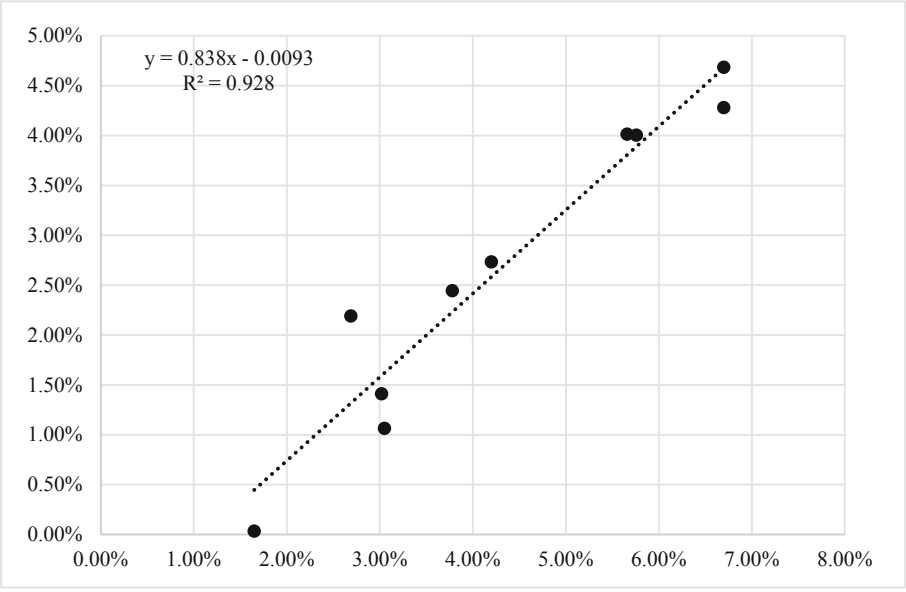

Fig. 2. Regression line for the estimate of β_t.

Table 6. Regression statistics for T_t.

	T_t
R multiple	0.96332
R^2	0.927986
R^2 correct	0.918984
Standard error	0.004413
Observations	10

Table 7. Standard error on β_t and T_t.

	Coefficients	Standard error	Stat t	Significance value	Lower 95%	Higher 95%
T_t	−0.00935	0.00383	−2.44088	0.040509	−0.01818	−0.00052
β_t	0.837984	0.082533	10.15327	7.58E−06	0.647662	1.028307

5 Estimation of Acceptability Threshold T_a and Tolerability Threshold T_t: Discussion of the Results

From the implementation of the formulas (7) and (10), we obtain the value of the acceptability threshold T_a and tolerability threshold T_t:

$$T_a = r_f + \beta_a \cdot (r_m - r_f) = 3.44\% + 1.26 \cdots (7.66\% - 3.44\%) = 8.90\%$$

$$T_t = r_f + \beta_t \cdot (r_m - r_f) = 3.44\% + 0.84 \cdots (7.66\% - 3.44\%) = 7.06\%$$

These thresholds represent limit values useful for assessing the risk and residual risk associated with projects in the "construction of buildings" sector in Italy. Thus, for such investments, the risk is:

- widely acceptable if $E(\text{IRR}) > 8.90\%$, i.e. if the expected internal rate of return is greater than 8.90%;
- unacceptable for the investor if $E(\text{TIR}) < 7.06\%$;
- ALARP $7.06\% < E(\text{TIR}) < 8.90\%$.

It is worth remembering that the European regulatory guidelines do not provide clear indications on the acceptability levels of the project risk. So, the proposed methodology based on the comparison between $E(\text{IRR})$ and performance limit values can be a useful guide for the analyst when judging the economic performance of risky investments.

6 Conclusions

The aim of the paper is to provide the analyst with guidelines for assessing the risk of investments in the "building construction" sector. To this end, risk acceptance thresholds are first defined, then a methodology is outlined to estimate these thresholds.

The theoretical reference useful for establishing the risk thresholds is the ALARP logic. From this logic, widely consolidated in safety risk management in industrial procedures, the concepts of acceptability threshold and risk tolerability threshold are borrowed. According to this logic, investment risk can be defined as low as reasonably practicable if it is included among the above-mentioned thresholds or if the costs to mitigate it appear disproportionate to the benefits that can be pursued [4–8].

To estimate the tolerability and acceptability thresholds of the investment risk, the CAPM is used. Through this approach, it is possible to relate the risk of the project not only to the return of the production sector in which the project falls, but also to the return of the market in its entirety. Indeed, the CAPM allows evaluating the risk-adjusted discount rate r(β), which can be interpreted as the expected return from an investment with a risk profile β [9].

Operationally, the joint use of the CAPM and statistical investigation methods enables to calibrate the limit values of risk acceptability and tolerability for investments in a specific sector, based on a statistically significant panel of Return on Investment (ROI) values for companies operating in a specific territorial context. In particular: the acceptability threshold T_a coincides with the expected return of a project with a risk profile that represents the "worst" companies in the sector falling within the survey territory, or those belonging to the lower quartile; the tolerability threshold T_t, on the other hand, is assessed as the expected return of an investment with the risk profile of the "mean" company in the sector.

In the second part of the paper, the analysis of the profitability indices of 6949 companies in the "building construction" sector and 2095 manufacturing companies, all active in Italy in the decade 2009–2018, makes it possible to estimate values of the tolerability thresholds T_t and acceptability thresholds T_a of the investment risk of 7.10% and 8.90% respectively. This means that an investment in building construction in Italy has a risk: a) unacceptable, that is, it is necessary to plan mitigation actions, if E(IRR) < 7.06%; b) which falls within the ALARP area, or is tolerable (in the sense that further mitigation measures have costs disproportionate to the persuasive benefits), if 7.06% < E(IRR) < 8.90%, c) broadly acceptable, therefore there is no need to envisage any containment action, if E(IRR) > 8.90%.

Since it is able to estimate the risk in quantitative terms, the proposed methodology can be of help in the decision-making processes, until it becomes a real economic policy tool.

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