A Rigorous Mathematical Approach to the Economic Rate of Return (ERR) and its Application to Economic Analysis
Fadi Asrawi

Abstract
The economic rate of return (ERR) is a measure of the profitability of a revenue generating investment based on a single external discount rate which is the hurdle rate or the minimum attractive rate of return (MARR). In this paper, we will highlight on the practical and reasonable interpretation of the (ERR) as a reinvestment rate of the present worth of costs. We shall give the usual mathematical definition of the (ERR) and derive an alternative, more useful, and applicable definition in terms of the benefit-cost ratio. We will also investigate the behavior of the (ERR) function in terms of the (MARR) as a variable. A relationship between the (ERR) and the internal rate of return (IRR) will be established. Finally, the applicability of the (ERR) method as an economic analysis method will be demonstrated.

Keywords:
Investment; Hurdle rate; Present worth; Future worth; Benefit-cost ratio; internal rate of return

Introduction
The economic rate of return (ERR) is a rate simply calculated from the cash flow of an investment that measures the profitability of the investment. This is done by using an external rate which is the hurdle rate or the (MARR). The (ERR) is different in its interpretation than the internal rate of return (IRR). It is the equivalent rate per period at which the present worth of the investment expenditures is considered to be invested to yield a future worth equal to the future worth of the revenues invested at the (MARR) rate, while the (IRR) has no reinvestment, but a relationship exists between the two rates as we shall prove later in this paper.

Literature Review
Several financial methods are in use today when the decision maker is faced with many alternatives. These methods include present worth (PW), annual worth (AW), future worth (FW), Economic rate of return (ERR), benefit-cost ratio (B/C), Internal Rate of Return (IRR) and Minimum Attractive Rate of Return (MARR). The results of these methods usually deliver reliable results to infer an optimal decision. The usages of these methods differ based on the preferences of the decision- maker as each method has its list of advantages and disadvantages.

The Economic rate of return (ERR) and benefit-Cost ratio (B/C) are usually used as an index of profitability in making the final decision to accept or reject an investment project and are applicable only on an incremental basis. The ERR is widely accepted in the industry .Using ERR allows decision makers to analyze investments in percentage ERR terms, which makes it more appealing to decision-makers. PW, FW and AW on the other hand can be applied to both total and incremental decisions as they use an absolute measure of investments.

The Minimum Attractive Rate of Return (MARR), which is also referred to as the hurdle rate, cutoff rate, benchmark rate, and minimum acceptable rate of return has been established for the evaluation and selection of alternatives. If a project is not expected to return at least the MARR, then the project is not worth considering. The cost of the needed capital funds has a major influence on the size of MARR, which will heavily impact the investment decision.

The IRR usage could cause many interpretational and operational problems. If the goal is to rank competing mutually exclusive alternatives, using the IRR of projects or their financial alternatives, is, generally, conceptually unsound, using the NPV, or any NPV-compatible evaluation criterion including the IRR is a better approach for ranking.

When a project produces multiple IRRs within the economically meaningful range (-100%,+∞) of the discrete interest rate, it would be hard to interpret the results meaningfully. Research has shown that the IRR defines the ROR on the investment unrecovered balance and not the ROR on the whole project investment.

Fadi Asrawi
Haigazian University, Lebanon, fadi.asrawi@haigazian.edu.lb
Conclusion

In this paper, we highlighted the mathematical properties of the Economic Rate of Return. We also established a relationship between the ERR and the IRR and suggested a financial interpretation of the ERR. We proved that the ERR method can be utilized as an economic analysis method just like present worth, annual worth, the IRR and the benefit-cost ratio methods. We showed the advantage the ERR has over the IRR both in interpretation and application. We also tackled economic analysis using the ERR in case of stochastic cash flow, and came up with an approximation formula for the expected ERR. Future research can focus on economic decision based on the ERR in the case of many exclusive stochastic investments.

References

1. Sullivan WG, Wicks EM, Koelling CP (2009) Engineering Economy (14th edn), Prentice-Hall, p: 696.
2. Hajdasinski MM (1993) Payback period as a measure of profitability and liquidity. The Engineering Economist 38: 177-191.
3. Bernhard RH (1962) Discount methods for expenditure evaluation clarification of their assumptions. The Journal of Industrial Engineering.
4. Park CS (2010) Contemporary Engineering Economics (3rd edn), Prentice-Hall, New Jersey.
5. Newnan DG, Whittaker J, Eschenbach TG, Lavelle JP (2010) Engineering Economic Analysis, Engineering Press, (2nd Canadian edn).
6. Newnan DG (2004) Engineering Economic Analysis (6th edn), Engineering Press, San Jose, California.
7. Sullivan WG, Wicks EM, Luxhoj JT (2006) Engineering Economy (13th edn), Prentice-Hall, New Jersey.
8. Blank LT, Tarquin AJ (2005) Engineering Economy (5th edn), McGraw-Hill, New York.
9. Steiner HM (1992) Engineering Economic Principles (2nd edn), McGraw-Hill, New York, 1992.
10. White JA, Case KE, Pratt DB, Agee MH (1998) Principles of Engineering, Economic Analysis, Wiley, New York.
11. Cannaday RE, Colwell PF, Paley H (1986) Relevant and Irrelevant Internal Rates of Return. Engineering Economist 32: 17-38.