Personal Skills: Economic Analysis of Mineral and Energy Investments

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Upon graduation from college several years ago, I thought that I was sufficiently prepared to embark in my chosen profession. A short time later I realized that several years of on-the-job training was going to be required before I could use my technical training effectively. It never occurred to me that, professionally, I was seriously lacking in any other skills. My spelling could use a little upgrading, but this was not a serious deficiency.

I have been very fortunate to have had two employers that recognized that their engineering professionals did lack other skills and made every effort to give them training to correct these deficiencies. The skills I am referring to are those in administration and interpersonal relationships. Most mining engineers and geologists receive very little, if any, college training in these areas. In addition, many companies do not provide this training and many mining engineers and geologists are unaware of their deficiencies. It is for this reason the subject of personal skills development is being introduced in Mining Engineering.

The mining engineer or geologist can pursue one of two basic career directions, managerial or technical. In today’s technically sophisticated society and highly competitive business climate, both orientations require administrative and interpersonal skills. Most of us are technically qualified and we continue to upgrade our technical skills. But many studies indicate that we, as a group, are significantly weaker in administrative and interpersonal skills than other professional groups. In addition, these studies indicate that engineers, in general, take longer to reach managerial levels and fewer do so. This series in Mining Engineering, then, should help readers strengthen and broaden their professional capabilities.

In all industries, including mining and petroleum, economic analysis of potential investment projects is done to select the projects that will give maximum future value from the investment of available capital. Rather than looking directly at the future values to be generated by investing capital in alternate ways for economic decisions, evaluators usually use either rate of return, present value, annual value, a profit to investment ratio, or various breakeven analysis results to reach economic analysis decisions in evaluating alternative investments.

Alternative economic evaluation techniques are used in industry to properly analyze the economic potential of various investment projects. “Discounted Cash Flow” analysis is the phrase commonly used to describe these techniques. Whether you want to analyze projects in mineral, petroleum, real estate, refining, pipeline transportation, or any other industry, proper application of discounted cash flow analysis techniques enables you to fairly compare the economic potential of alternative projects as well or better than you can using any other project evaluation approaches.

It should be pointed out that investment analysis generally involves more than economic analysis. Financial and intangible considerations sometimes are as important or more important to investment decision-making than economic considerations. Economic analysis refers to evaluation of the profit generating potential of projects, that is selecting which alternative projects will generate maximum future value possible from available investment capital. Financial analysis, on the other hand, relates to analysis of where money is going to come from to finance various projects. Regardless of the economic potential of a project, if financial analysis indicates that we cannot finance the project, it likely will be shelved for financial reasons even though it may be economically satisfactory. Many evaluators use the terms “economic analysis” and “financial analysis” interchangeably, but this author considers that to be undesirable.

Intangible analysis relates to project factors that are difficult to quantify in

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dollars. Legal considerations, public opinion and goodwill, political factors, and environmental considerations may cause a project to be accepted or rejected regardless of the economic potential of the project or available financing. This article primarily concerns economic analysis of projects. But that does not mean that financial and intangible considerations are not important to the investment decision-making process.

Economic Analysis Techniques

Discounted cash flow analysis of projects relates to analyzing inflows and outflows of money over the life of a project using one of six basic economic analysis evaluation tools at the disposal of evaluators. These tools are present value, future value, annual value, rate of return, break even calculations, and a ratio of present value to cost worth investments. The terms "cost" and "worth" are used here and in general evaluation work to have interchangeable meaning. All six of these evaluation techniques involve handling the time value of money using compound interest rate of return. With all the techniques, except rate of return analysis, the appropriate compound interest rate to use in the analysis time value of money calculations is the rate that is thought to represent other opportunities for the investment of capital. The rate is commonly called either the opportunity cost of capital, minimum rate of return, hurdle rate, or just discount rate. With rate of return analysis, the time value of money is handled at an unknown interest rate, i, and trial and error determine the i value that makes project costs equivalent to inflows of money on a present, future, or equivalent annual value basis. This i value is the project compound interest rate of return (ROR). It is compared to the rate that represents other opportunities thought to exist for the investment of capital to reach an economic decision. It would be evident that a project ROR greater than the rate representing other investment opportunities indicates an economically satisfactory project.

The term opportunity cost of capital gets its name from the fact that an opportunity cost is incurred if we forego investing in a project with rate of return potential, say i*, in order to invest in another new project. Similarly, minimum rate of return comes from other projects with rate of return potential (i*) where it is believed you can invest, economically, the minimum rate of return that any new project can have and still be satisfactory is i*.

The term hurdle rate is derived from rationale similar to minimum rate of return. To be economically satisfactory, a new project must have a rate of return that huddles (is greater than) the rate representing other investment opportunities. Discount rate is often used for simplicity instead of hurdle rate or the other terms.

Finally, notice that no mention has been made of the cost of borrowed money in describing the basis for the interchangeable terms opportunity cost of capital, minimum ROR, hurdle rate or discount rate. It does not matter where the money is coming from, whether borrowed from the local bank or using the company's own cash equity, the objective in investment analysis is to determine how to invest capital to maximize future value.

Cash Flow Definition and Calculation Assumptions

Cash flow represents the net difference between inflows and outflows of money during a given operating period such as a year, quarter, month, or week. Before-tax or after-tax cash flow can be calculated. Positive cash flow results when inflows of money exceed outflows during a period. Conversely, negative cash flow indicates costs exceed inflowing dollars. Discounted cash flow evaluation techniques are systematic, quantitative approaches that evaluate the economic potential of projects for given sets of assumptions.

To effectively use a discounted cash flow analysis result, whether it be present value, rate of return, or a ratio, the assumptions that go into determining the project cost and revenue parameters and the basis for the cash flow calculations need to be understood. Non-government organizations generally need to evaluate projects after-tax and often a choice of several different approaches exists under tax law for handling tax deductions and credits. These tax handling differences sometimes have a significant effect on economic analysis results so the decision-making manager must understand the basis of cash flow calculations if he or she is to have any hope of using discounted cash flow analysis results correctly for decision-making purposes.

There is nothing magic about any of the discounted cash flow results. They are quantitative measures of the economic potential of a project and they are only as valid and useful as the input data and cash flow calculation assumptions.

Escalation and Inflation

Many people use the terms escalation and inflation interchangeably. Escalation refers to changes in price or value (up or down) of specific goods and services at stated times. Inflation refers to the change in price or value of some average basket of goods such as a consumer price index that, in the US, is a basket of about 400 different goods and services. When talking about escalation, you are dealing with specific goods, services, and commodity price projections; whereas inflation refers to the change in an average basket of goods, services, and commodity prices.

In determining input cost and revenue data for project analysis, escalation rates on individual project items are used to predict the actual project costs and revenues to be incurred over the project life. Then there is a choice of going in either of two directions. A project can be analyzed using escalated dollar analysis (sometimes called current dollar, nominal dollar, or inflated dollar analysis) by working with the project escalated dollar costs and revenues. Or, the project can be analyzed using constant dollar analysis (sometimes
called real or deflated dollar analysis), by annual inflation rates to some common point in time, typically the start of the project.

Proper project analysis in either escalated or constant dollars using any valid discounted cash flow analysis technique always give the same economic conclusions concerning the best projects. Do not mix escalated and constant dollar results. As long as all projects are compared in the same kind of dollars (escalated or constant), you consistently get the same economic choices.

Escalated dollar analysis is simpler and less confusing than constant dollar analysis to most people. That probably is why most companies and individuals (75-80%) use escalated dollar analysis of projects instead of constant dollar analysis. It is correct to use either approach as long as it is consistent.

Uncertainty and Risk

When involved in projection of costs and revenues that is necessary for economic analysis, there is uncertainty concerning the validity of projected values. Sensitivity analysis measures the effects of uncertainty in economic analysis calculations by recalculating discounted cash flow results such as rate of return or present value for changes (up or down) in parameters such as cost and revenue input data parameters or tax considerations.

Risk analysis, on the other hand, involves building finite probability of failure into the economic analysis calculations using expected value analysis mathematical procedures. Risk adjusted, or expected value, rate of return or present value results represent statistical long run average results that can be expected to be realized over many repeated tries of ventures of the type being analyzed.

Cash Investment Versus Leveraged Investment Analysis

Leverage commonly refers to the effects of borrowed money in economic analysis calculations. When borrowed money is used in addition to your own equity capital to achieve your investment objective, financial leverage is being used.

Leverage project analyses involve two basic differences from cash investment analyses. First, interest on borrowed money is tax deductible as an operating expense that cash investment analysis does not have. Second, the use of borrowed dollars changes the distribution of investor equity costs by deferring equity costs into the future when borrowed dollar principal payments have to be made. These differences cause leveraged project economic results to look better than cash investment economic results if the after-tax cost of borrowed dollars is less than the case investment after-tax rate of return (DCFROR) of the project into which the borrowed dollars are being invested.

Since the economics of most projects with reasonable profitability can be made to look even better with leverage, be careful to look at all project analysis results with the same or similar amounts of leverage. It is not fair to enhance the economics of one project with leverage and then compare that result to results from analyzing another project on a cash investment basis. Most companies make cash investment analysis the common basis for comparing project economics. Even if borrowed money is to be involved in a project development, it is common to compare the economics of that project with other projects on a cash investment basis. This accounts for the fact that all project economics will be changed with leverage, so analysis calculations must be consistent.

Finally, remember leverage can and will work against you if the cost of borrowed money exceeds what the money is earning in the invested project. Many companies in the early 1980s lost more money faster with leverage debt incurred in the late 1970s than if they had stayed on a cash investment basis. The old economic axiom "there ain't no free lunch" applies very well to leveraging investments. Leverage provides the opportunity of making money faster, but also the possibility of losing money faster.

Important Economic Analysis Situations

All investment analysis projects in any organization, industry, or country fall into one of two categories—income producing projects, or service producing projects. Some refer to a third category, involving savings producing investments, but that situation results from making incremental analysis of service producing investments.

Whether analyzing income producing investments or service producing investments, it is important to be aware that either of these categories can involve evaluation of either mutually exclusive alternatives, or nonmutually exclusive alternatives.

Mutually exclusive alternative analysis refers to evaluation of several investment alternatives from which only one can be selected, such as determining the best of several possible ways to improve or develop an operation or project. Analysis of alternative development plans for ore bodies and petroleum reserves are examples of mutually exclusive analysis in minerals and petroleum.

Nonmutually exclusive alternative analysis means evaluation of several investment alternatives that are independent, so that the selection of one has no effect on selecting any other nonmutually exclusive alternative. The ranking of drilling projects in petroleum and exploration projects in minerals are examples.

Applying discounted cash flow evaluation techniques is different when analyzing nonmutually exclusive and mutually exclusive alternatives. Incremental analysis is the key to correct evaluation of mutually exclusive alternatives using any analysis technique; whereas to evaluate nonmutually exclusive alternatives evaluation, techniques must be used that rank the alternatives in the order that you want to select them to get maximum value for available investment capital. Many managers and evaluators are unaware that discounted cash flow rate of return and net present value in general do not properly rank nonmutually ex-
clusive alternatives in the desired selection order. To rank nonmutually exclusive alternatives, either growth discounted cash flow rate of return (growth DCFROR), a ratio of net present value (NPV), or present worth cash flow to present worth investment must be used. To get maximum profitability (future value) possible from available investment capital in evaluating many independent projects, select alternatives that have money growing at the greatest rate (growth DCFROR) or that give the most NPV or present worth cash flow per dollar invested.

To summarize mutually exclusive and nonmutually exclusive alternative analysis, the following statements are relevant: In evaluating mutually exclusive alternatives, proper total investment and incremental project analysis always leads to selecting the individual project with maximum NPV but that is not the mutually exclusive alternative with maximum DCFROR or ratio. In evaluating nonmutually exclusive alternatives, proper total investment analysis involves selecting the project with maximum ratio or growth DCFROR as first choice, next largest value as second choice and so forth. Neither NPV nor DCFROR is a proper nonmutually exclusive ranking tool, that is, nonmutually exclusive alternatives with maximum NPV or DCFROR sometimes are not the best economic choices.

Financial Considerations Affect Analyses

Whether an individual investor or company has existing streams of income and tax obligations against which to use tax deductions and credits often has an impact on cash flow calculations and discounted cash flow evaluation results. Projects must be evaluated using project costs, revenues, tax considerations, and financial situations most likely to exist at various times over the project evaluation life. If existing streams of income from the other projects do not exist against which to use exploration, development, drilling, or research tax deduct-

ons in early project years, then the negative taxable income must be carried forward as a loss forward deduction until income from the project being evaluated is sufficient to offset the loss forward deduction. If other income exists against which to use deductions, credit the project being evaluated with tax savings from deductions in the year taken. It is incorrect to make project economics stand alone if other income exists against which to use deductions.

When the end-of-the-year tax return is filed, income and deductions from all projects are consolidated, so if income exceeds deductions, the taxpayer realizes the tax benefits from all deductions in that year. It is correct and proper to credit potential new projects with tax benefits from deductions in the year incurred if other income exists. Carry losses forward if other income does not exist.

Evaluation Questions Often Encountered

A question often encountered with respect to DCFROR analysis is whether or not reinvestment of project positive cash flows at the DCFROR rate is implicit or explicitly tied to the meaning of DCFROR results. The answer is there is no implicit or explicit positive cash flow reinvestment assumption tied to the meaning of DCFROR results in any way.

A second question is "What causes multiple rates of return to occur in certain project analysis situations?" When having alternate investment, income, investment or income in analysis calculations, the potential for multiple (usually dual) rate of return results. Further, the multiple rate of return results have combination rate of return and rate of reinvestment requirement meanings at different stages of the project. They are therefore not valid for decision-making purposes as rate of return results. Using net present value analysis to analyze projects in these situations is one valid way to avoid the multiple rate of return difficulties.

A third question commonly asked is "Which investment analysis technique is best?" There is no definite answer for all analysis situations because different techniques have economic analysis advantages in various mutually exclusive and nonmutually exclusive analysis situations. If only one technique could be selected and used, however, net present value (NPV) analysis is preferred for simplicity and consistency in leading to correct economic evaluation results. NPV does not rank nonmutually exclusive alternatives correctly, but it is easy to calculate the ratio of NPV to present worth investment cost as a variation of NPV that does properly rank nonmutually exclusive alternatives.

Conclusions

The discounted cash flow investment analysis techniques are the best approaches known for evaluating the economic potential of alternative investments. It is important to remember that all of the discounted cash flow techniques are systematic, quantitative approaches to evaluating investments based on given sets of assumptions and input data. If you put garbage in, you will get garbage out of any analysis calculation using any technique of analysis. There is nothing magical about discounted cash flow results.

It must be understood that the cash flow calculation assumption concerning tax consideration, handling inflation and escalation, risk adjusting or not risk adjusting results when finite probability of failure exists, the financial situation of the individual or organization for which the analysis is being made, significance of terminal value magnitude and timing, and correct handling of the discounted cash flow analysis calculations, whether it involves DCFROR, NPV, ratio analysis, or another technique.

Proper use of the discounted cash flow analysis techniques gives investors a better chance of correctly analyzing the potential of alternative investments than can be achieved using any other evaluation technique.