PINCOCK Perspectives

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Economic Evaluation of Mining Projects

CALENDAR

- ***China Mining 2005***
  November 14–17, 2005
  Beijing International Congress Centre
  Beijing, China
  e-mail: jan.klawitter@china-mining.com

- ***Mines and Money London***
  November 21–23, 2005
  Hilton London Metropole Hotel
  London, United Kingdom
  e-mail: tracey.fielder@mining-journal.com

- ***Gold & Precious Metals Investment Conference***
  November 27–28, 2005
  San Francisco Marriott
  San Francisco, California
  e-mail: iiconf@iiconf.com

- ***NWMA Annual Convention: Exploring the Modern Minerals Renaissance***
  December 5–9, 2005
  Red Lion Hotel at the Park
  Spokane, Washington
  e-mail: pheywood@nwma.org

- ***Mineral Exploration Roundup 2006***
  January 23–26, 2006
  Westin Bayshore Resort & Marina
  Vancouver, B.C., Canada
  e-mail: llelliott@chamberofmines.bc.ca

- ***Runge Professional Development Courses***
  Mining for Non Miners - Nov. 30
  Dragline Mining System - Dec. 1-2
  Mining Economics - Dec. 5-6
  Truck and Loader Systems - Dec. 7-9
  Calgary, Alberta, Canada

Introduction

In order for mining companies or investors to make statements regarding the mineral reserves of a project, security exchanges throughout the world require owners to validate the economic viability of the project. Engineers typically make this determination through economic evaluation using a tool called cash flow analysis. Simply stated, a cash flow analysis is **cash in** (revenue from sales) less **cash out** (direct operating costs, taxes, royalties, capital expenditures – or any out-of-pocket expenditure) which yields **net cash flow**. These cash flows are typically estimated on an annual basis and discounted back to the present moment in time to determine the discounted cash flow rate of return (DCFROR) or net present value (NPV) of the project.

Economic evaluation and financial analysis are commonly, though incorrectly, used interchangeably. Economic evaluation is the method used to determine the economic viability of a project. It is the primary measure of alternative investment opportunities. Financial analysis is the method used to analyze how a project will be funded; whether it will be 100 percent owner equity, a combination of equity and debt, a joint venture arrangement or some combination of these financial terms. However, cash flow analysis can be used to evaluate the economic impact of the various financing options on the project.

Economic evaluation can be used virtually any time in a project's life: from the pre-exploration stage to assist in determining the size and tenor of a mineral target (conceptual level), during the exploration stage (pre-feasibility level), through project development and financing (feasibility level). As projects progress through the various stages of evaluation, the cash flow model parameters will be replaced with better estimates and engineering data in order to determine if the project merits the additional funding necessary to progress to the next level. DCFROR is the after-tax rate of return that discounts future cash flows by properly taking into account the time value of money. The method is also referred to as the internal rate of return.

DCFROR is defined as that rate of return that makes the after-tax present worth of future cash flows from the project equal to the present worth of after-tax investments. If the project's DCFROR is greater than the company's minimum rate of return, the project is considered economically viable. Discounting future cash flows is done through formulas of compound interest, discussions of which can be found in economic engineering or accounting books.

DCFROR is used in conjunction with other economic parameters such as NPV and payback. NPV is defined as the difference between the present worth of future cash flow and the present worth of initial investment using a predetermined discount rate (preferably the company's minimum rate of return). If the difference is positive, the project is considered economically viable. DCFROR and NPV are related in that the DCFROR is the discount rate where the NPV of the project is zero.

Payback is a simple method that does not incorporate time value of money concepts. Payback is the period of time required to payback the initial investment from future cash flow. Although the method does not account for time value of money, it is a useful evaluation parameter because it provides some indication of how long the company has to wait to get its money back. A company may be able to survive 2 to 4 years before positive cash flows arrive. Periods of much longer time than this may strain companies beyond their financial means.

The concept of minimum rate of return is a significant discussion by itself where authors have

devoted entire books to the subject. Several factors make up the minimum rate of return, which in general terms consist of the company's cost of capital with some allowance for risk. Most evaluators look to the company's chief financial officer to provide the minimum rate of return for economic evaluations. Although determining the minimum rate of return for projects is beyond the scope of this paper, suffice it to say that determining the minimum rate of return is not a simple calculation.

Companies often request evaluators to perform economic evaluations on a pre-tax basis for a variety of reasons. However, most people do not realize that pre-tax evaluations require one to use pre-tax discount rates, which are not the same as after-tax discount rates. As just discussed, determining a minimum discount rate is a complicated matter, without having to calculate a new pre-tax discount rate. It should also be noted that pre-tax evaluations are not acceptable to establish mineral reserve statements because taxes represent operating costs and are therefore, required to be included in the cash flow analysis.

There are two basic situations in evaluating projects: 1) one is referred to as 'stand-alone' where all tax deductions and credits are carried forward and used against future project income and taxes, and 2) the other is when the project is evaluated within the corporate envelope where income exists elsewhere in the organization such that all tax deductions, credits and savings are taken when incurred to gain the most favorable economic advantage. Although some companies may have no choice, companies tend to evaluate projects using 'stand-alone' as the base case. While this evaluation does not present the best economic scenario, it does tend to allow the projects to be evaluated on their own merit. Later in the evaluation process, companies can incorporate the project into the corporate evaluation scenario to analyze the combined economic advantages.

DCFROR and NPV are the most widely used investment decision methods in the mining industry because they properly account for time value of money and they allow different mineral projects to be analyzed on a common basis. These methods allow companies to properly rank investment alternatives in order to make the best decision where to employ their money.

Mine Planning and Cash Flow Analysis

Economic evaluation of alternative mine plans requires estimation of the project's mine and process production parameters, royalties, operating costs, taxes, capital costs and ongoing capital replacement costs. Table 1 illustrates what goes into a typical cash flow for any given year.

Table 1 Annual Cash Flow Diagram

Gross Revenue
Less transportation, smelter/refining, marketing and downstream beneficiation charges
Less royalties
Less operating costs
Net Operating Revenue
Less non-cash items:
Depreciation
Depletion
Amortization
Net Taxable Income
Less taxes
Plus credits
Net Income After Tax
Plus non-cash items
Net Operating Cash Flow
Less capital costs (initial and sustaining)
Less working capital
Less acquisition costs
Less land payments
Net Cash Flow

Gross revenue from the mine takes into account annual tons produced, ore grade, mine recovery, and process recovery all multiplied by commodity price to generate total gross revenue. Deductions from gross revenue consist of product transportation costs from the mine site, additional beneficiation costs and marketing costs. Royalties based on net smelter return value are calculated at this point, further reducing gross revenue. Direct operating costs including mining, processing, general, administrative, property taxes, severance taxes, corporate overhead charges and ongoing reclamation costs are subtracted from gross revenue, generating net operating revenue.

Unless the operation has the enviable position of a negotiated tax holiday during it's first few production years, net operating revenue is subject to taxation. Taxation typically includes national (federal), state (provincial) and local taxes. Non-cash items, which may consist of depreciation, depletion and/or amortization, are applied to reduce taxable income. Non-cash items are neither capital nor operating costs, but rather an allowance used to reduce taxable income. Use of non-cash items to reduce taxable income is dependant on laws of the governing entity as levied by the taxing authority. Restrictions or additional taxes may be levied on income leaving the governing country. It is the responsibility of the company and the evaluator to gain an understanding of the governing nation's tax law, which often means employing local tax knowledge to assist in properly interpreting and applying the necessary tax laws.

As mentioned earlier depreciation and depletion are non-cash allowances. Depreciation is an allowance for capital investment over the useful life of an asset. Most countries allow some form of depreciation for the majority of mining industry assets. Countries may have several categories of depreciation depending on the asset's use. Generally the faster the write-off, the more likely this will trigger some form of alternative minimum tax calculation. Depletion is an allowance for a nonrenewable resource. Depletion is only allowed in some countries.

Every country has some class of taxation generally taking many different forms. While companies may have negotiated an income tax holiday, there may be other forms of taxation such as the value added tax (VAT) on not only final product sales, but major equipment components coming into the country. Although it's likely the company will receive a tax credit for VAT later in the project's life, the money is required at the project's startup, adding to capital investment.

Once taxes are removed from the income stream, the mine operator is left with net operating cash flow. Net operating cash flow is further reduced by capital costs, changes in working capital, acquisition costs and required land payments. The resulting calculation yields the project's annual net cash flow. This calculation is performed for every production year and each additional year beyond the last production year where reclamation is required. These net cash flows are discounted to a present time to determine the NPV and DCFROR of the project.

One important component of cash flow analysis that requires special attention is working capital. Working capital is the money required for day-to-day operations. It is particularly critical during the project's startup phase and is often a significant expense requirement. However, working

capital is not the usual capital expense and as such, is not an allowable tax deduction. Cost items typically included in working capital are: 1) inventories such as raw materials, spare parts, supplies, product-in-process and finished products, 2) accounts receivable, 3) accounts payable, and 4) cash on hand. Depending on the level of project study, working capital may be estimated using detailed accounts of the aforementioned items or through order-of-magnitude estimates based on 10-20 percent of the fixed capital investment or 1- 3 months of operating costs taking into consideration the type of process and how long before the first saleable product is available to market. Remote project locations may require a higher working capital cost.

While working capital is invested at the startup of an operation, it is usually shown as being recovered at the end of the project's life because the components initially required are considered recouped at the end of mine life. However, some companies are providing more working capital throughout the project life to allow for various unknowns and fluctuating monetary exchanges or increases. In some cases working capital may be recovered early in the project life or it may never be recovered, depending on the project's circumstances.

Sensitivity Analysis

It is highly recommended that the evaluator perform the primary project economic evaluation based on a project stand-alone situation and 100 percent owner equity (no debt financing). This case will provide a sound baseline from which all other cases can be evaluated and compared.

Although engineers make every effort to reasonably estimate mine and process production parameters, as well as capital and operating costs, uncertainties exist, which need to be evaluated. These "what if" concerns can be addressed through sensitivity analysis.

The cash flow program can be setup to evaluate changes in tons, grade, recovery, product price, capital and operating costs relative to different discount rates. Evaluators typically graph the results in "spider diagrams," which illustrate the impact on project economics when any one parameter is changed while other parameters are held constant. The steeper the curve the more sensitive project economics is to the change in the parameter. The range of changes generally runs plus or minus 10 to 20 percent, or possibly higher for conceptual level studies.

These results provide the company with a sense of critical parameters indicating which ones should be closely monitored. Generally one of the primary parameters most sensitive to project economics is revenue followed by either operating or capital costs. Revenue factors consist of grade, recovery and price and a given percentage change in any one of these carries exactly the same impact on revenue.

Although sensitivity analysis is an important aspect in economic evaluations, it is a single point parameter test. Sensitivity analysis does not account for the likelihood or probability of any particular parameter being within a certain range or distribution nor how that distribution impacts the project's economics. While probability theory with respect to economic evaluation is very interesting, its subject matter is beyond the scope of this paper. With the proliferation of computer software, several commercial packages are available to test a project's economics to various probabilistic models.

Limitations of DCFROR and NPV

Although DCFROR and NPV are probably the most widely used and generally accepted economic evaluation tools available in the industry, they are not without limitations. Neither DCFROR nor NPV account for the magnitude of the investment in a project. A project with a capital investment of $100 million may show the same DCFROR as a project requiring a $1 billion investment. DCFROR does not account for differing project lives. A project with a 10 year life may show nearly the same DCFROR as a project with a 20 year life. NPV is the only tool which can adequately account for projects with varying lives.

The main point of this is that companies and investors should not rely solely on one economic parameter for decision making. It is important and perhaps critical that all available economic parameters be used together to provide a reasonable picture as to the economic health of a project. Armed with the project's economic evaluations and the political analysis of various countries, companies should be in a good position to make an informed decision regarding the mineral property.

Leverage and the Effect on DCFROR and NPV

Not that long ago most projects were financed from the owner's equity capital. More recent projects are of such magnitude and risk that other sources of capital are required to bring the project into production. Debt financing is one such source, which is why it is worth discussing the impact leveraging has on DCFROR and NPV.

One common mistake when evaluating projects using borrowed money is to perform the cash flow analysis on the total investment rather than just the equity portion of the investment. This is another reason why evaluators should perform a base case analysis using 100 percent equity. It provides a baseline to compare leveraged evaluations.

If the after-tax cost of borrowed money is less than the project's cash investment DCFROR, then it is economically desirable to borrow the money and defer the remaining equity investment. This will significantly increase the DCFROR and NPV of the project by leveraging up these indicators. However, it is important to note that leveraging works both ways. If the project's DCFROR falls below the cost of borrowed money the project will not be able to service the loan and will generate a significantly negative NPV.

Summary

The process of economic project evaluation using cash flow analysis can be a long, complicated and arduous task. As the project progresses and more detailed information becomes available, the mineral evaluation process becomes more complex and requires further evaluation. This situation is somewhat unique to the mining industry and it is very much a circular evaluation process..

Economic evaluation through the use of cash flow analysis will generate a project's DCFROR and NPV, which allows us to systematically and quantitatively evaluate the economic potential of various mineral investments. DCFROR and NPV are the most widely used investment decision methods in the mining industry because they properly account for time value of money and they allow different mineral projects to be analyzed on a common basis. These methods allow companies to properly rank investment alternatives in order to make the best decision where to employ their money.

Example Cash Flow Analysis

Table 2 provides an example cash flow diagram with the various parameters illustrated as discussed in this paper. Any resemblance to an actual project is merely coincidental.

Table 2
CASH FLOW STATEMENT ($1,000 US)
GOLD MINE PROJECT
OWNER EQUITY (100%)

YEAR	PreProd Y1	PY1	PY2	PY3	PY4	PY5	PY6	PY7	PY8	PY9	PY10	PY11	TOTAL
MINE REVENUE	**0**	**13,441**	**17,921**	**17,921**	**17,921**	**17,921**	**17,921**	**17,921**	**17,921**	**17,921**	**17,921**	**22,402**	**197,134**
LESS: NSR ROYALTY (5.0%)	0	672	896	896	896	896	896	896	896	896	896	1,120	9,857
LESS: MINING COST	0	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	0	0	0	32,000
LESS: PROCESSING COST	0	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	33,000
LESS: G&A COST	0	400	400	400	400	400	400	400	400	400	400	400	4,400
LESS: LEACH PAD DETOX	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS: RECLAMATION	0	500	500	500	500	500	500	500	500	200	200	200	4,600
TOTAL OPERATING COSTS	0	8,572	8,796	8,796	8,796	8,796	8,796	8,796	8,796	4,496	4,496	4,720	83,857
NET CASH FLOW FROM OPERATION	**0**	**4,869**	**9,125**	**9,125**	**9,125**	**9,125**	**9,125**	**9,125**	**9,125**	**13,425**	**13,425**	**17,681**	**113,277**
LESS: INTEREST EXPENSE	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS: DEVELOPMENT COSTS	2,730	910	0	0	0	0	0	0	0	0	0	0	3,640
LESS: DEPRECIATION	0	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655	3,655	40,200
LESS: DEPLETION	0	152	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	2,554	3,192	26,328
TAXABLE INCOME (LOSS)	-2,730	152	2,917	2,917	2,917	2,917	2,917	2,917	2,917	7,217	7,217	10,835	43,109
INCOME TAX @ 44% + PROP TAX	-1,201	122	1,387	1,387	1,387	1,387	1,387	1,387	1,387	3,328	3,328	4,969	20,259
TAX ADJUSTMENT	-1,201	122	1,079	0	0	0	0	0	0	0	0	0	0
INCOME TAX PAID	0	0	309	1,387	1,387	1,387	1,387	1,387	1,387	3,328	3,328	4,969	20,259
NET CASH FLOW FROM OPERATION	**0**	**4,869**	**9,125**	**9,125**	**9,125**	**9,125**	**9,125**	**9,125**	**9,125**	**13,425**	**13,425**	**17,681**	**113,277**
LESS: TAXES	0	0	309	1,387	1,387	1,387	1,387	1,387	1,387	3,328	3,328	4,969	20,259
LESS: CAPITAL COSTS	36,800	3,400	0	0	0	0	0	0	0	0	0	0	40,200
LESS: FINANCED CAPITAL	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS: WORKING CAPITAL	0	2,143	0	0	0	0	0	0	0	0	0	-2,143	0
LESS: DEVELOPMENT COSTS	3,900	1,300	0	0	0	0	0	0	0	0	0	0	5,200
LESS: ACQUISITION COSTS	300	200	0	350	0	325	0	0	0	0	0	0	1,175
LESS: LAND PAYMENTS	0	26	26	26	26	26	26	26	26	0	0	0	207
LESS: INTEREST EXP.	0	0	0	0	0	0	0	0	0	0	0	0	0
LESS: PRINC. PAYMT	0	0	0	0	0	0	0	0	0	0	0	0	0
ANNUAL CASH FLOW	**-41,000**	**-2,200**	**8,791**	**7,362**	**7,712**	**7,387**	**7,712**	**7,712**	**7,712**	**10,097**	**10,097**	**14,856**	**46,236**

CASH FLOW SUMMARY

Gold Price ($/Oz):	**400**
DCFROR:	**12.0%**
PROJECT NPV @ 5%:	**$20,208**
PROJECT NPV @ 10%:	**$4,491**
PROJECT NPV @ 15%:	**($5,244)**

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