A PRACTICAL APPROACH TO PETROLEUM ECONOMICS

Larry Hastings
HNG Oil Company

ABSTRACT

This paper is a general explanation of the financial mechanics of an oil and gas economic project analysis. Emphasis is placed on the meanings and usage of certain financial terms and ratios such as interest rate, present value, future value, discount rate, internal rate of return, payout period and return on investment.

INTRODUCTION

Have you ever wondered how a company makes money; how it knows what to invest in to generate sufficient dollars to pay salaries, to pay taxes, to provide a dividend and/or interest payment to its stockholders and bondholders and, even after all of that, to have enough funds left to continue its operation and even expand its operation into some future time? Obviously, companies must invest their capital wisely or else eventually become bankrupt. Even individuals have to make certain judgmental decisions about each one's own private financial matters in order to make sure they and their families are able to meet their present financial expenses and needs while at the same time providing for future needs and future prosperity.

Basically, the financial problem of the individual and the corporation is the same, how to invest its available funds in such a manner as to maximize its future income.

In order to make money (i.e. generate future revenues), a company must generally make a capital investment in one or more endeavors or projects that have a reasonable chance of returning to the company its original investment plus, after it pays its expenses and taxes, some additional amount of money over and above what the original investment could have earned in a bank. Usually a company has more investment opportunities for its funds than it has capital to invest. I hazard to guess most individuals are in the same boat. Obviously, then, the company must evaluate in some manner the investment opportunities it has available to it and choose those investments which will generate, given a fixed amount of current investment capital, a maximum amount of future revenues.

Before delving into how to evaluate specific investment opportunities or projects, a short discussion of what is generally called the time value of money is needed. First, money is a commodity, and the use of money can be bought and sold for a period of time. Second, money has a value now called the present value, and it also has a value some time in the future called the future value. The future value of money can be either greater than the present value or it can be less depending upon the economics of a particular transaction. Someone who sells money (banks for instance) sells its use over a specific period of time for a premium. Obviously, someone who buys the use of the money for a specific period of time must pay the seller a premium for the use of the money. The premium the seller receives or the buyer pays is called the interest and is usually expressed as a percent. Then if a company borrows $1,000 from a bank for a period of one year at a simple interest rate of 10 percent, at the end of one year the company must pay back to the bank $1,100. The $1,000 principle thus loaned or borrowed has a present value of $1,000 to both the loan maker and the borrower at the beginning of the loan period. To the bank, the $1,000 loan has a future value of $1,100 at the 10 percent interest rate because over the one year period of the loan, it earned $100 in interest. Another way to look at this particular loan transaction is to say the $1,100 to be received by the bank one year from now has a present value of $1,000 at an interest rate of

10 percent. In the latter usage, the interest rate is called the discount rate and is used to convert future dollars, sometimes called real dollars, to present day dollars, sometimes called discounted dollars.

The present value and future value of any amount of money can be determined by the following formula:

$$FV = PV\ (1+i)^n$$

where FV is future value
PV is present value
i is the interest rate per time period
n is the time period

The concept of the time value of money is the cornerstone of all financial analysis whether it be lending money, borrowing money, dealing with inflation, or a project analysis. The concept of the time value of money is certainly illustrated in the old saying about inflation that a dollar today is worth more than a dollar tomorrow.

PRODUCTION, PRICES AND REVENUE

In a discussion of project financial analysis, the first items of importance that have to be known are estimates of (1) the initial investments that will be made, and (2) estimates of the future revenue streams, along with the timing of those revenue streams, that will be derived from the initial investments. Figure 1 is an example of the before federal income tax portion of a commercially available computerized oil and gas economic model.[1] The project being evaluated in the example is the drilling of a proposed developmental gas well. As can be seen, the portion of the example shown in Figure 1 is simply a computation of the total yearly net revenue the company will receive from the project before any operational expenses and capital cost (investments) are deducted. Generally speaking, it doesn't matter if the company is producing oil and gas or widgets, the revenue is simply the gross units of production produced, reduced by some factor to reflect the company's actual ownership in the units produced times the expected sales price of each unit. As can be seen in the example (Figure 1), the yearly units of production are not constant, and the sales price of the production is expected to increase every year.

A word of wisdom should be injected here: any financial analysis or project evaluation is only as good as the basic production, prices, cost, and escalation information used in the formulation of the analysis. Many companies, financial institutions, and individuals are in deep financial trouble at the present time because they failed to properly analyze and account for the basic data used in the financial analysis of their investment opportunities. We, in the oil and gas industry, know now that the expectation in the near future of $100 per barrel oil and $10 per MCF gas was a serious and, at times, fatal assumption. Accuracy in the basic data and assumptions used in an analysis is all important.

EXPENSES, CAPITAL COST, AND BTAX CASH FLOW

Figure 2 is a tabulation of the cost and of the before federal income tax cash flow, discounted and undiscounted, of our example project. The operations cost section is the estimate of the actual net yearly out-of-pocket expenses with which our example project is expected to be burdened. In this case the expenses are the state (severance) and local (ad valorem) oil and gas production taxes, the Federal Windfall Profits tax on oil, and the company production expenses. These expenses, when deducted from the total net revenue generated from the sale of production, gives the operations cash flow. The operations cash flow is the funds expected to actually flow into the company treasury after the initial investment has been made.

The capital cost section of Figure 2 is simply a tabulation of the investments that the company is expected to have to make in order to fund the project. The breakdown of the capital cost, in the case of an oil and gas well project, is tangible well cost, intangible well cost, leasehold cost, and salvage value. Tangible well cost and leasehold expenses are investments that the company made for physical, real property (i.e. land, wellhead and production equipment, etc.). In other words, the tangibles are the stuff that a person can actually go out and touch and reclaim (sell) at the end of the life of the project. The intangible costs are those investments, that when spent, can never (theoretically) be recovered (for instance the cost of drilling and completing the well). Salvage value is not a cost but is actually a revenue. It is the expected value of the tangible investment (equipment) and leasehold at the end of the project. The final two columns shown in Figure 2 are the expected cash flow before federal income taxes in undiscounted future dollars and the cumulative cash flow before federal income tax discounted back to current dollars. The cash flow BTAX column in undiscounted dollars is the expected actual future yearly dollars this project will generate. The cumulative discounted BTAX column is the summation of the discounted yearly cash flows. This column represents the future value of the project to the company in current dollars. Of course, inherent in the cumulative discounted BTAX cash column is the assumption that the yearly operations cash flow revenues are reinvested each year at the indicated project discount rate. Then if the summation of the yearly discounted cash flows is greater than zero, the project is generating an internal rate of return on the original investment greater than the specified project discount rate. In addition, had the summation of the yearly discounted cash flow been less than zero, the project would be generating an internal rate of return on the original investment less than the specified discount rate. The internal rate of return as a profitability parameter will be discussed further in the paper.

So far, in our example analysis, it has been shown that by making an initial investment in a project, a company can expect that project to generate specific yearly revenue streams and that associated with those generated revenues are certain expenses that must be deducted from those revenue streams. Finally, to this point, it has been shown that the operations cash flow minus the investments (capital cost) generates the total project cash flow before federal income tax and this total project cash flow BTAX yields some amount of money in both future real dollars and discounted present day dollars.

DEDUCTIONS, FEDERAL INCOME TAXES, AND ATAX CASH FLOW

As everyone knows, the government requires that federal income taxes be paid on income. It doesn't matter whether the payee is a corporation, a partnership or an individual, if a profit is made, and that is really what it's all about, income taxes have to be paid. However, the government through the various tax laws, does allow certain write offs and capital recoveries from the operational income of an income-generating project. Obviously, these write-offs and recoveries affect the bottom line profit that a project will generate and, thus, they must be accounted for in the financial evaluation.

Figure 3 shows the after tax economics for the example project. The objective here is to calculate taxable income, federal income taxes payable, and ultimately the after tax cash flow given that certain write-offs and recoveries can be deducted from the project operations cash flow. Since it is not the purpose of this paper to discuss the various tax laws (they are forever being changed anyway); the discussion of depreciation, depletion, and investment tax credits will be minimal. Obviously, if required to do a detailed project analysis from scratch, it would be prudent to consult with a good, up-to-date tax accountant.

Let it suffice here to say that depreciation and depletion is the recovery of certain project capital cost. Depreciation is the recovery of that portion of the capital cost that was perviously called tangible cost. Depletion is the recovery of that portion of the capital cost that was previously called leasehold cost.

Intangible expenses, as were defined earlier, are deducted in total in the year that they incurred. Interest expenses, defined here as being the yearly interest cost on the unpaid principle (original investment), is deducted yearly as if it were an intangible expense. In the example project shown, the assumption is that the original project investment was internally financed by the company and is not being financed with borrowed money. Thus, the example shows no interest expense in the interest column, while probably unrealistic, the assumption of internal financing does simplify the example analysis.

Now referring to Figure 3, it can be seen that the deduction of the yearly depreciation, depletion, intangible expenses, and interest expenses from the yearly operations cash flow stream gives the yearly taxable income stream. It is this amount of yearly project revenue that is assumed to be subject to the federal income tax. In this example the applicable federal income tax rate is the maximum corporate tax of 46 percent. Here again, the federal tax rate is variable, depending upon the corporation's or individual's adjusted gross income. Consult the local or corporate tax accountant to make sure the proper federal income tax rates are being used. Before proceeding to calculate the federal income taxes payable and ultimately the cash flow of the project after federal income taxes, it should be noted that the government allows a one time deduction from the taxes payable of a certain percentage of the capital investment. The amount of deduction (investment tax credit) allowed is dependent upon the type of depreciation scheduled for the tangible cost. Again, the percentage of investment tax credit allowed is a question for the old reliable tax accountant.

The federal income taxes payable are calculated, as shown in the Taxes Payable column of Figure 3, and are then deducted from the taxable income in order to arrive at our project cash flow after federal income taxes. This column represents the yearly ATAX cash flow of the project in real future dollars. The summation of the yearly ATAX cash flows is the amount of after tax income or profit that the original investment is expected to generate. Again, as was done in the before tax calculation, the yearly after tax cash flows are discounted at the project discount rate. If the summation of the discounted ATAX cash flows is greater than zero, the project is said to have an ATAX internal rate of return greater than the specified project discount rate.

PROFITABILITY PARAMETERS

As can be seen, the process of accounting for all of the project revenues, expenses, deductions and taxes can be a laborious task. However, once these tabulations are completed, certain financial ratios can be computed in order to evaluate the economic soundness of the project.

Figure 4 is a presentation of several of the major aspects of the example project and, most importantly, it shows the profitability ratios and the present worth profile. The profitability ratios shown in Figure 4 are the discounted rate of return, the payout period, and the net income to investment ratio for the project. The BTAX and ATAX rate of return shown in Figure 4 is the internal rate of return of the project. By definition, the discounted internal rate of return is that discount rate that, when applied to the yearly cash flows, makes the summation of the discounted cash flows equal to the amount of original investment.

The payout period is that period of time it takes for the discounted and undiscounted cash flows of the project to generate in revenues, BTAX and ATAX, the amount of the original dollar investment. In other words, it is a measure of how long the project takes to pay back the original investment in both BTAX and ATAX dollars.

The net income to investment ratio is defined as the net income plus the investment divided by the investment. In other words, it is the number of real (undiscounted) and current (discounted) dollars, the project generates for every dollar of original investment.

The profitability ratios shown for the example in Figure 4 are basic to all financial project analysis. There are others, to be sure, but most are only variations of these basics.

The present worth profile table shown is Figure 4 is nothing more than the summation of the BTAX and ATAX yearly cash flows of the project at various discount rates. Each entry in the table is the present worth of the project at a particular specified discount rate. As can be seen, the discount rate where the present worth of the project is zero is the BTAX and ATAX (internal) rate of return of the project.

CONCLUSION

The discussion presented in this paper has been a walk-through of a rather simple oil and gas financial project analysis. It is hoped this paper has generated a basic understanding of how companies and individuals evaluate their various money making schemes. There remains only to present a few words of caution to be used when preparing and evaluating an economic analysis.

1. First and foremost, if the responsibility becomes yours to generate a financial project analysis, accuracy and credibility of the basic information (i.e. projections, prices, expenses, etc.) are most important. If the basic assumptions are faulty, the computation becomes simply an academic exercise and the results could be a decision by management to accept a marginal or even a down right dismal investment opportunity.

2. When examining the profitability ratios and parameters, make decisions based on all of the ratios and parameters. Keep in mind that payout period tells nothing about the total worth of the project. A project accepted solely on payout period might not generate additional income past the time it pays out. A project accepted solely on the income to investment ratio could be a project that has such a long life that the discounted rate of return is marginal. And finally, a project that is accepted solely on the internal rate of return could actually have a real rate of return less than indicated because inherent in the discounted rate of return evaluation process is the assumption that all cash generated each year by the project is reinvested at the specified project discount rate.

1. Economic Model - OGRE David P. Cook & Associates, Inc., Dallas, Texas

DO RIGHT OIL CO.
GUSHER #1
DEVONIAN TEST

DATE: 03/07/84
TIME: 08:47:38
FILE: GUSHER
GET#: 2

RESERVES AND ECONOMICS

AS OF JANUARY 1, 1984

-END- MO-YR	----GROSS PRODUCTION--- OIL, MBBL	GAS, MMCF	-----NET PRODUCTION---- OIL, MBBL	GAS, MMCF	---PRICES--- OIL $/B	GAS $/M	NO. OF WELLS	----------OPERATIONS, M$---------- OIL REVENUE	GAS REVENUE	OTHER REVENUE	TOTAL REVENUE
12-84	0.000	263.254	0.000	171.115	0.00	3.34	1.0	0.000	571.524	0.000	571.524
12-85	0.000	235.745	0.000	153.234	0.00	3.34	1.0	0.000	511.802	0.000	511.802
12-86	0.000	171.062	0.000	111.190	0.00	3.54	1.0	0.000	393.657	0.000	393.657
12-87	0.000	124.125	0.000	80.681	0.00	3.75	1.0	0.000	302.782	0.000	302.782
12-88	0.000	90.069	0.000	58.545	0.00	3.98	1.0	0.000	232.892	0.000	232.892
12-89	0.000	65.355	0.000	42.481	0.00	4.22	1.0	0.000	179.128	0.000	179.128
12-90	0.000	47.424	0.000	30.826	0.00	4.47	1.0	0.000	137.782	0.000	137.782
12-91	0.000	34.411	0.000	22.367	0.00	4.74	1.0	0.000	105.972	0.000	105.972
12-92	0.000	24.969	0.000	16.230	0.00	5.02	1.0	0.000	81.509	0.000	81.509
12-93	0.000	18.119	0.000	11.777	0.00	5.32	1.0	0.000	62.694	0.000	62.694
12-94											
12-95											
12-96											
12-97											
12-98											
12-99											
12- 0											
12- 1											
12- 2											
12- 3											
S TOT	0.000	1074.533	0.000	698.446	0.00	3.69	0.0	0.000	2579.742	0.000	2579.742
AFTER	0.000	0.000	0.000	0.000	0.00	0.00	0.0	0.000	0.000	0.000	0.000
TOTAL	0.000	1074.533	0.000	698.446	0.00	3.69	0.0	0.000	2579.742	0.000	2579.742

Figure 1 - Production, prices and revenue

-END- MO-YR	----------OPERATIONS, M$---------- SEV + ADV TAXES	WF PROFIT TAXES	NET OPER EXPENSES	OPERATIONS CASH FLOW	----------CAPITAL COSTS, M$---------- TANGIBLE COSTS	INTANG. COSTS	LSEHOLD COSTS	SALVAGE VALUE	CASH FLOW BTAX, M$	15.00 PCT CUM. DISC BTAX, M$
12-84	46.522	0.000	24.000	501.002	309.320	280.940	0.000	0.000	-89.258	-128.483
12-85	41.661	0.000	30.528	439.613	0.000	0.000	0.000	0.000	439.613	227.988
12-86	32.043	0.000	32.360	329.254	0.000	0.000	0.000	0.000	329.254	460.147
12-87	24.647	0.000	34.301	243.834	0.000	0.000	0.000	0.000	243.834	609.651
12-88	18.958	0.000	36.359	177.575	0.000	0.000	0.000	0.000	177.575	704.327
12-89	14.581	0.000	38.541	126.006	0.000	0.000	0.000	0.000	126.006	762.746
12-90	11.216	0.000	40.853	85.713	0.000	0.000	0.000	0.000	85.713	797.301
12-91	8.626	0.000	43.305	54.041	0.000	0.000	0.000	0.000	54.041	816.246
12-92	6.635	0.000	45.903	28.971	0.000	0.000	0.000	0.000	28.971	825.077
12-93	5.103	0.000	48.657	8.934	0.000	0.000	0.000	0.000	8.934	827.445
12-94										
12-95										
12-96										
12-97										
12-98										
12-99										
12- 0										
12- 1										
12- 2										
12- 3										
S TOT	209.992	0.000	374.807	1994.943	309.320	280.940	0.000	0.000	1404.683	827.445
AFTER	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	827.445
TOTAL	209.992	0.000	374.807	1994.943	309.320	280.940	0.000	0.000	1404.683	827.445

Figure 2 - Expenses, capital cost and BTAX cash flow

DO RIGHT OIL CO.
GUSHER #1
DEVONIAN TEST

DATE: 03/07/84
TIME: 08:47:38
FILE: GUSHER
GET#: 2

A F T E R T A X E C O N O M I C S

AS OF JANUARY 1, 1984

-END- MO-YR	OPER CASH FLOW, M$	DEPR. EXP., M$	DEPL. EXP., M$	INTANG. EXP., M$	INTEREST EXP., M$	TAXABLE INCOME M$	INVEST. CREDIT M$	TAXES PAYABLE M$	CASH FLOW ATAX, M$	15.00 PCT CUM. DISC ATAX, M$
12-84	501.002	44.078	0.000	280.940	0.000	175.984	30.932	50.021	-139.279	-174.588
12-85	439.613	64.648	0.000	0.000	0.000	374.965	0.000	172.484	267.129	42.020
12-86	329.254	61.709	0.000	0.000	0.000	267.545	0.000	123.071	206.183	187.401
12-87	243.834	61.710	0.000	0.000	0.000	182.124	0.000	83.777	160.057	285.538
12-88	177.575	61.709	0.000	0.000	0.000	115.866	0.000	53.298	124.277	351.798
12-89	126.006	0.000	0.000	0.000	0.000	126.006	0.000	57.963	68.043	383.344
12-90	85.713	0.000	0.000	0.000	0.000	85.713	0.000	39.428	46.285	402.004
12-91	54.041	0.000	0.000	0.000	0.000	54.041	0.000	24.859	29.182	412.234
12-92	28.971	0.000	0.000	0.000	0.000	28.971	0.000	13.327	15.644	417.003
12-93	8.934	0.000	0.000	0.000	0.000	8.934	0.000	4.110	4.824	418.282
12-94										
12-95										
12-96										
12-97										
12-98										
12-99										
12- 0										
12- 1										
12- 2										
12- 3										
S TOT	1994.943	293.854	0.000	280.940	0.000	1420.149	30.932	622.338	782.345	418.282
AFTER	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	418.282
TOTAL	1994.943	293.854	0.000	280.940	0.000	1420.149	30.932	622.338	782.345	418.282

Figure 3 - Deductions, federal income taxes and ATAX cash flow

BTAX RATE OF RETURN (PCT)	97.72	ATAX RATE OF RETURN (PCT)	60.59
BTAX PAYOUT YEARS	1.20	ATAX PAYOUT YEARS	1.52
BTAX PAYOUT YEARS (DISC)	1.36	ATAX PAYOUT YEARS (DISC)	1.81
BTAX NET INCOME/INVEST	3.38	ATAX NET INCOME/INVEST	2.33
BTAX NET INCOME/INVEST (DISC)	2.40	ATAX NET INCOME/INVEST (DISC)	1.71
PRODUCTION START DATE	3/ 1/84	PROJECT LIFE (YEARS)	10.00
MONTHS IN FIRST LINE	12.00	DISCOUNT RATE (PCT)	15.00
GROSS WELLS	1.00	PRIOR DEPL. BASIS (M$)	0.000
		PRIOR DEPR. BASIS (M$)	0.000
MAX. OIL PRICE ($/B)	0.00	MAX. GAS PRICE ($/M)	5.32
GROSS OIL WELLS	0.00	GROSS GAS WELLS	1.00
CUMULATIVE OIL (MBBL)	0.000	CUMULATIVE GAS (MMCF)	0.000
REMAINING OIL (MBBL)	0.000	REMAINING GAS (MMCF)	1074.533
ULTIMATE OIL (MBBL)	0.000	ULTIMATE GAS (MMCF)	1074.533
INITIAL W.I. FRACTION	0.80000000	FINAL W.I. FRACTION	0.80000000
INITIAL NET OIL FRACTION	0.00000000	FINAL NET OIL FRACTION	0.00000000
INITIAL NET GAS FRACTION	0.65000000	FINAL NET GAS FRACTION	0.65000000

----PRESENT WORTH PROFILE-----		
DISC RATE	PW OF NET BTAX, M$	PW OF NET ATAX, M$
0.0	1404.683	782.345
2.0	1301.859	718.184
5.0	1165.852	632.903
8.0	1048.107	558.651
10.0	978.128	514.315
12.0	914.024	473.558
15.0	827.445	418.282
18.0	750.713	369.047
20.0	704.265	339.126
25.0	601.935	272.869
30.0	515.725	216.648
35.0	442.185	168.370
40.0	378.764	126.476
45.0	323.531	89.775
50.0	275.009	57.353
60.0	193.748	2.638
70.0	128.372	-41.808
80.0	74.603	-78.683
90.0	29.572	-109.821
100.0	-8.728	-136.509

Figure 4 - Profitability parameters