Financial evaluation of Sungun Copper Project using DCF method

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Abstract

The Sungun copper mine that operated by National Iranian Copper Industries Company (NICICO) is a world class project of great magnitude and complexity. A detail financial model of the Sungun Copper Project was constructed. The Internal Rate of Return (IRR) of the base case is 18%. At a discount rate of 6.5% the Net Present Value (NPV) of the Project is $1,554M at a copper price of $4,500/t. The breakeven copper price at the 6.5% discount rate is $2,460/t. The most sensitive factors, as is usual in projects of this nature are copper price and discount rate. Because of the contractual mining system, OPEX is slightly more influential than CAPEX.

Keywords*:* DCF analysis, CAPEX, OPEX, IRR, NPV, Breakeven copper price;

1 Introduction

The state-owned Sungun Copper Project (SCP) is located in the East Azarbaijan Province in the North West of Iran and is the second largest copper mine in the country [1]. The border with Turkey lies some 200 km to the west. The Aras River that also forms the border of Iran with Armenia and Azarbaijan lies approximately 40 km to the north of the mine. The Sungun copper deposit is a porphyry type where the predominant copper mineralization is copper sulfide occurring as the mineral chalcopyrite. The ore of the Sungun deposit is made up of two distinct types, supergene and hypogene. The supergene ore is weathered and forms a cap on the bulk of the ore, which is hypogene. The supergene material makes up about 25% of the total ore body and is the major ore type feeding the concentrator in the early years of operation. The supergene ore has a copper content of approximately 0.75% Total Copper (T Cu) which is higher than the Hypogene material but because it contains oxide copper exhibits a lower metal recovery. A summary of the two ore types as reported by Lakefield Research in head ore assays of the pilot scale testwork is given in the Table 1.

Table 1- Ore types and recoveries of Sungun orebody [2]

Ore Type	*Grade, T. Cu, %*	*Grade, Oxide Copper, %*	*Total Copper Recovery, %*	**Sulfide Copper Recovery, %**
Supergene	0.78	0.16	80.2	92.4
Hypogene	0.67	0.03	92.3	93.6

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Svedala company that has recently bought out by Metso Minerals, have developed the process plant design and produced flow sheets, mass balances, basic engineering, some detailed engineering and P&IDs.

The analysis and mineralogical work carried out on the ore has indicated that gold is not present in commercially exploitable quantities. Further tests and investigations are in process to do further testwork with a view to incorporating separation plant if justifiable sometime during production. Lakefield Research investigated the possibility of producing a separate molybdenum concentrate. This is not a viable proposition for the supergene ore as the head grade is too low at a reported value of 0.008%. The molybdenum minerals are all oxide type, molybdenum oxide, ferric molybdate and calcium molybdate all of which exhibit poor flotation response. The molybdenum grade of hypogene ore is also low but higher than supergene at about 0.031%. The molybdenum is distributed in the form of the sulfide mineral, molybdenite, which when associated with copper sulfide minerals can be recovered by a complex flotation process. Though former investigations indicated that molybdenum grades are low and co-production with copper was unlikely to be economically feasible, but further investigations is underway to evaluate molybdenum production. The recently tight supply situation and the relatively high market price of molybdenum have led to numerous investment projects in mines as well as in roasting facilities [3].

The mine comprises a large open pit commencing at a maximum ground level of around 2,350 m (top of the mine) and the final base level of 1,625 m. The Phase 1 plant and mine have a nameplate capacity of 7 million tonnes of sulfide copper ore per year and has been commissioned in mid 2006. The minable ore is estimated to be 388 Mt including 2 Mt of recoverable copper content. The ore and waste extracted by contractors. During the Phase 1, the copper concentrate production is 150,000 tonne which will be reached to 300,000 tonne in 2013. The produced concentrate transported to Sar-Cheshmeh Copper Complex, 2,200 km far from the mine, for effectively toll smelting. A Smelter has been considered originally but was not a viable option at site as the throughput from Sungun alone, even during the Future Phases production levels, was considered to be inadequate for a commercial operation. An alternative was to source additional feed from other copper operations in the area or Armenia and Azarbaijan. Following the recent copper jumping in price, NICICO decided to expand the downstream copper production facilities by establishment of an 80,000 tonne smelter, a 90,000 tonne refinery plant a 350,000 tonne acid plant with the worth of $ 800M inside the mine site.

Heidari and Rashidinejad (2004) evaluated the final mine design and calculated the Internal Rate of Return (IRR) and the Net Present Value (NPV) of the project 6.7% and -$4.6M respectively at a copper price of $2,000/t [4].

2 Discounted Cash Flow (DCF) Analysis

It can be argued that the worth of a project is the value of the project's future cash flows (or other net benefits) less the required investment (or costs). However, the time in which the investments and returns are received is also an important factor. Consideration of present and future investment and revenue streams over time forms the basis for all discounted cash flow analysis measures [5]. DCF analysis has been a prominent technique for performing valuations and budgeting scarce capital for the past several decades. It is based on cash flow and is easily understood by engineers and accountants. Discounted cash flow techniques constitute the basis of investment decisions for most mining companies, though have a number of major problems such as inflation and discount rate assumptions [6].

The DCF technique evaluates the whole project by adjusting, or discounting, the project net cash flow for the effects of risk and time. If a project risk is high and project life is long then the DCF will be small. Under this method, there are several evaluation criteria such as net present value (NPV), internal rate of return (IRR), benefit cost ratio (B/C), and payback time for evaluating a mining project.

3 Financial Evaluation

A financial model was developed that model project cash flows and calculate economic indicators, such as IRR and NPV for the production phase. A sensitivity analysis was carried out to determine the risks and economic robustness of the project. The model is based on the:

• Open pit production schedule;
• Projected plant recoveries and throughput;
• Capital expenditures (CAPEX) schedule;
• Estimated mine and process plant operating expenditures (OPEX), including general and administration costs;
• Concentrate transportation cost;
• Treatment charge (TC) and refining charge (RC);
• Sales costs and the
• Product sales prices.

The resulting project cash flow model – in Excel spreadsheet format – is generated a cash flow before tax for each year. The model is prepared on an "all equity" basis and in constant money terms (i.e., without inflation and escalation), to permit the robustness of the project to be readily seen.

4 Construction of cash flow model

4.1 General Principals

Project cash flows are considered to be spent at the beginning of each year and therefore year 2007 has been discounted. IRR and NPV are calculated using the standard Excel® formulae. The purpose of the model is as a tool with which to optimise the project.

Assume that estimates on the future cash flows of the purposed project are sound. The success of the discounted cash flow technique then depends on how well the analysts choose the discount rate. If a picked rate is too high, projects that add value to the firm will be unnecessarily rejected. On the other hand, if the discount rate is too low, projects that do not add value to the firm will be accepted. Therefore, choosing the appropriate discount rate is an important as the estimation of appropriate future cash flows. The net cash flow for each year end has been discounted at a rate of 6.5%, composed of 4% costs of money and 2.5% technical risk. This rate can be changed, since the choice of risk factor will be affected by the cost of capital in the future and the perceived risks attached to the project by the investor.

4.2 Open Pit Production Schedule

The production scheduling is provided in Table 2.

Table 2- Annual production schedule

Year	**Ore**	**Average Cu grade**	**Supergene Ore**	**Supergene Grade**	**Hypogene Ore**	**Hypogene Grade**
	(t)	**(%)**	**(t)**	**(%)**	**(t)**	**(%)**
1	5,000,000	0.725	4,802,764	0.740	197,236	0.343
2	6,696,485	0.699	6,190,719	0.718	505,766	0.471
3	6,996,988	0.817	6,726,092	0.828	270,896	0.544
4	6,997,205	0.926	6,531,275	0.948	465,930	0.629
5	6,993,764	0.956	5,920,528	1.001	1,073,236	0.708
6	6,995,014	0.936	5,608,958	0.997	1,386,056	0.689
7	13,998,485	0.866	10,277,780	0.944	3,720,705	0.651
8	13,983,051	0.641	6,691,004	0.699	7,292,046	0.588
9	13,960,734	0.553	8,321,424	0.575	5,639,310	0.520
10	13,983,778	0.659	7,378,079	0.699	6,605,698	0.614
11	13,990,532	0.640	4,153,545	0.701	9,836,987	0.615
12	13,999,195	0.665	2,618,646	0.872	11,380,550	0.618
13	13,996,971	0.591	3,095,311	0.742	10,901,660	0.549
14	13,997,972	0.627	3,509,950	0.765	10,488,022	0.580
15	13,990,398	0.550	2,191,138	0.549	11,799,260	0.550
16	13,959,935	0.444	5,254,781	0.462	8,705,154	0.433
17	13,961,563	0.574	4,930,214	0.597	9,031,349	0.561
18	13,981,418	0.584	2,865,616	0.524	11,115,802	0.600
19	13,984,152	0.604	1,519,374	0.536	12,464,778	0.612
20	13,969,925	0.587	1,475,176	0.646	12,494,749	0.579
21	13,986,101	0.601	1,649,488	0.674	12,336,613	0.592
22	13,665,402	0.497	1,766,096	0.455	11,899,306	0.503
23	13,331,586	0.436	598,462	0.344	12,733,124	0.440
24	14,000,000	0.575	843,132	0.591	13,156,868	0.574
25	14,000,000	0.505	160,061	0.470	13,839,939	0.506
26	14,000,000	0.543	55,152	0.448	13,944,848	0.543
27	14,000,000	0.583	21,891	0.566	13,978,109	0.583
28	14,000,000	0.593	78,494	0.913	13,921,506	0.591
29	14,000,000	0.576	0	0	14,000,000	0.576
30	14,000,000	0.558	0	0	14,000,000	0.558
31	13,896,151	0.532	0	0	13,896,151	0.532
Total	**388,316,803**	**0.611**	**105,235,149**	**0.745**	**283,081,654**	**0.561**

The currency exchange rates change daily, and long-term trends associated with inflation and other fundamental factors occur though not in a predictable manner. The currency crises Iran is typical. Therefore, over the economic life of the project, substantial changes could occur, but it is exceedingly difficult to predict what they will be. These exchange rate changes, beside other factors, make international capital investment quite complex, thus increasing the riskiness of foreign investment. SCP/NICICO had used an exchange rate between 3,030 and 8,000 I.R.Rials/$ during the implementation phase of the project but the exchange rate of 9,000 I.R.Rials/$ in the late stages of construction stage and early stages of operation considered and therefore used in the financial model. The year 2006 set as year zero and sunk costs incorporated into the CAPEX. The foreign loans for the concentrator plant considered to be paid based on the contract from 2006 to 2014 and for the future phase the same procedure with the factor of 1.5 is considered. SCP/NICICO reimbursed all local loans promptly after copper price jumping. This influenced the project cash flow positively as the interest rate of the local loans was too high in comparison with foreign loan.

SCP/NICICO enjoys a contractual extraction/mining system (i.e., SCP/NICICO retains ownership of the deposit). It is not possible to compare the two directly as there are benefits to both routes of extraction. Australian and US mining companies have favoured contractors in the past but are now returning operations to in-house ownership due to unacceptable entailments.

A contractor should be no less expensive than an in-house operation. Indeed, a contractor should, if one is comparing like to like, be more expensive as the contractor will not have the advantageous access to money that most major mining operations have. The contractor has to purchase equipment without the ability to negotiate the same price as a major mining company, he will have to support interest charges but is unlikely to obtain as favourable conditions as the mining company, and the contractor still has to charge a profit margin. He should not, therefore, be an attractive proposition.

The contractor only becomes attractive by undercutting labour rates, working to lower standards or saving on an item that the operating company cannot, due to their company charter, match. An example would be the ability to hire and fire at will to reduce personnel expenditures to closely fit needs; to provide minimal facilities, medical support, pension rights, etc. which a major mining operation cannot avoid.

Additionally, the mining company will have to also consider the cost of finalisation of contracts. Most international contracts extend over a period of years with reconciliation at set intervals. Generally the contractor then enters a dispute with the mining company and there is an appreciable amount of litigation, discussion and finally agreement. This is an expensive procedure. The mining company can avoid this but it does attract an additional cost. Most mining companies are moving away from contract mining as it should be cheaper to manage an operation within the company as well as affording the company complete control over the operation. A $1.14/t (24,000 I.R.Rials/m^3) mining cost applied to the model for mining operating cost.

For both processing and tailings disposal costs a $2.0/t and for fixed costs a $5.0M/y applied. One year real data was available and included in the model, so the results are reliable.

Based on current market data a smelting charge of $183/t concentrates and a refining charge of $132/t of payable copper metal with no price participation (PP) clause were considered. As the concentrate is transported to Sar-Cheshmeh Copper Mine, 2,200 km far from the mine, a transportation charge of $23/t of concentrate was considered too.
A $4,500 /t copper price included in the model that is predicated to be realistic for long term.

4.3 Model Conclusions and Sensitivity Analysis

The financial evaluation of mining projects is based on values of variables that are estimated from sparse and/or unreliable data [7]. The risk associated with a mining project comes from the uncertainties involved in the industry. Uncertainties can be classified as "internal" and "external". Internal sources of uncertainties relates to the ore body model and in situ grade distribution, technical mining sophistications, such as ground condition, equipment capacities, workforce and management. The external sources consist of commodity price, political/country risk, environmental conditions, legislation and government policy [8].
It is also important to differentiate between two types of risks (1) project risk, and (2) financial risk. Project risk is the inherent uncertainty surrounded the level of pre-tax profits that will be generated by the project. It arises because it is usually impossible to forecast several variables that form the project cash flow accurately. Financial risk is the additional risk introduced because of gearing in the capital structure. The level of fixed interest financing in the capital structure determines the financial risk. The probability of cash insolvency increases with the level of gearing used by the firm, as does the variability of the earnings available for ordinary shareholders. The fixed interest loans have to be paid regardless of whether the company is making profit, but paying dividends to the providers of share capital can be avoided in poor years. Producing a financial model and with sensitivity analysis can be used for ranking the sensitive economic indicators for a specific project. This methodology is still useful to evaluate the risks and economic robustness in the global mining industry.
In accordance with the aforesaid assumptions for SCP, the IRR of the base case is 18% and the breakeven copper price is $2,460/t. Table 3 and Table 4 show the sensitivity analysis of the project.

Table 3- Sensitivity analysis on NPV

Description	**Minus (M$)**	**Base Case (M$)**	**Plus (M$)**
Copper Price +/- 10%	1,211	1,554	1,897
Operating Costs +/- 10%	1,636	1,554	1,472
Capital Costs +/- 10%	1,630	1,554	1,478
Net Sales Revenue +/-10%	1,242	1,554	1,866
Discount Rate +/-2% Absolute	2,135	1,554	936
Exchange Rate +/-10%	1,433	1,554	1,653

Table 4- Sensitivity analysis of IRR to copper prices

c/lb	**$/t**	**IRR%**
1.0	2,205	4.6
1.5	3,307	12.4
2.0	4,409	17.6
2.5	5,512	21.6
3.0	6,614	24.9
3.5	7,716	27.8
4.0	8,818	30.3
4.5	9,921	32.5

The payback period expressed in years is the time period need for the accumulated net cash flow inflow to equal the total investment. In most mining applications, the typical cash flow pattern comprises an initial series of large investments in exploration and development, followed by increasing income after production commences. The financial model of SCP shows the payback period at the end of the year four.

5 Conclusion

An all equity model for SCP was constructed using Excel spreadsheet. This facilitate to instantly see the influence of any changes in expenditures and revenues on economical indicators such as net present value, internal rate of return, and payback time of a mining project. This methodology is also useful for financial evaluation and risk management of mining projects.

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