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ECONOMIC EVALUATION OF SURFACE COAL MINING PROJECT

BANKERS' PERSPECTIVE

by

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ABSTRACT

This thesis presents several evaluation techniques from a banker's perspective. The Discounted Cash Flow Rate of Return and the Net Present Value methods are applied to measure the profitability of a project. The Payback Period method is used as a risk indicator. Since the bank pays primary attention to the repayment of the loan, the Cash Flow Debt Coverage Ratio is employed as a measure of repayment. These methods are then applied to an actual surface coal mining project. Several of the risks of the project financing are presented. The bank must understand these risks before evaluating the project.

Evaluating both the all-cash investment case and the leveraged case, the effect of leverage is carefully considered. A typical bank would examine the all-cash case in order to avoid a marginal project, since borrowed money usually makes a project look better. Sensitivity analysis on the investment project considered shows that coal price is the most critical parameter. Due to this price sensitivity we would recommend that the price projections be restudied, and that shortening the time period of the loan be seriously considered.

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1. INTRODUCTION

Due to post-embargo oil supply and price uncertainties, coal is expected to become an important alternative to oil as an energy source. Coal reserves are abundant, and their distribution involves less political risk than that with, for example, oil from oil-exporting countries as Iran and Iraq.

Japan is presently a country with scarce domestic energy resources, so it must import sufficient energy resources to maintain economic growth. Today, developing new energy projects requires a large amount of capitalization. This tends to insure that Japanese companies, such as a trading company or an electric power company will be required to participate in overseas projects.

Japanese commercial banks try to develop their international dealings, partly because domestic competition becomes severe and partly because their major customers (big private companies) have become very active in foreign countries. Among these banks, the project-finance-type loan, which is discussed later, seems profitable because the bank can usually apply a higher interest rate to it. This kind of loan is associated with long loan terms, large investments, and large uncertainties. This implies that Japanese banks require different evaluation techniques for decision-making in such loans relative to evaluation of ordinary loans.

The purpose of this thesis is to present and demonstrate the evaluation techniques for project-finance-type investments, especially from the viewpoint of the banks. The thesis describes and illustrates how borrowing money has an influence on the project itself, comparing a borrowing money case with an all-cash investment case.

The second chapter provides an overview of project finance methods and the considerable risk level of this kind of loan. In the third chapter, the outlook of the coal market is discussed briefly. It includes a discussion of the Japanese Government's energy policy concerning coal. The fourth chapter gives the project profile, including data and assumptions, which is evaluated in this thesis.

The fifth chapter provides the economic evaluation of this particular project. Cash flow analyses, which include both the all-cash investment case and the borrowed money case, are considered. Several decision criteria are also discussed here. These are the Discounted Cash Flow Rate of Return (DCFROR) and Net Present Value (NPV) decision criteria. DCFROR is the discount rate which equates the present value of positive cash flows to the present value of negative cash flows (Mackenzie, 1970, p45). NPV is expressed in dollars and is the present value of some future net cash flows discounted at a given rate (Capen, Clapp, and Phelps, 1976, p542). For the evaluation of large investments, these techniques are considered to be superior to other conventional techniques such as accountant rate of return, because they take into account the time value of money. Payback period criteria, which are often used in the real world, are also discussed in this section. Payback period means the number of years required to compensate an original investment from positive cash flows, measured from the start of production (Mackenzie, 1970, p44). In addition, several sensitivity analyses are made. Sensitivity analysis indicates the effect of a given change of one input parameter, keeping all others constant (Mackenzie, 1970, p46).

Chapter six briefly discusses several considerations on the use of individual evaluation techniques, such as inflation and exchange rate. Finally, the concluding chapter summarizes the results of this particular evaluation.

Unless otherwise stated, the metric system will be used throughout this thesis.

Monetary units used in this thesis are in current United States dollars unless otherwise stated.

2. PROJECT FINANCING

2-1 A Discussion of Project Financing

Project financing includes the methods lenders use to finance a project that greatly rely on the anticipated cash flow of the projects (Wilson, 1976, p.69). Recently "Project Financing" has become increasingly popular within the financial community. Many major banks have established staff departments specializing in project financing in the United States. Until some years ago, Japanese commercial banks did not get into project financing partly because they were faced with vigorous demand for domestic borrowing. Recently, however, the Japanese economy has moved to a moderate-growth stage, and many major private companies are trying to reduce their bank borrowing in order to be flexible in the current financial situation. (A high debt-equity ratio is one of the distinctive features of Japanese private companies.) As a result, the competition for loans to low-risk companies has become more severe. For instance, banks compete by reducing interest rates to superior companies. Some major Japanese banks are laying stress on the work of their international division. Above all, "project financing" seems to be preferrable because of the large profits of these loans, although they have higher risk levels compared with ordinary loans.

Generally, there are three types of project financing (Castle, 1975, pp.18-25). The first type is non-recourse project financing. In this case only the cash stream generated by the project is the source of payout. If the project fails, lenders cannot ask the operating company to compensate them. This situation forces lenders to do a careful feasibility study and economic projection and carefully consider several risks. (These risks are considered in a later section.) Such project financing is called productions payment loans. These loans are repayable only out of some percentage of the cash flow of the project, which may not be backed up to any extent by the general credits and/or the assets of the sponsors of the project (Wilson, 1973, p.92).

The second type of project financing is financing covered by a guarantee of completion. In this case, many major risks during the construction period are eliminated by a guarantee of completion. After completion, the situation of lenders is the same as in the first type. It goes without saying that lenders should examine the factors of the guarantee carefully, such as completion date, overrun costs, and so on. This type of project financing is most common in the real world.

The third type is project financing supported by an undertaking for the life of the financing (secured loan). In this case, lenders can shift all project risks to the sponsors of the project through some guarantees. The cash flow of the project is still the source of repayment of the loan, but if this cash flow is not sufficient for payout, lenders have the right to ask project sponsors to otherwise compensate for the difference. Working capital maintenance agreements are one of this type of guarantees. Actually this type of project financing looks like ordinary term loans.

Some of the advantages of project financing to the sponsors are now considered. First, the capital requirements of most projects today call for a great deal of money. It is difficult to develop big natural resource ventures without debt (Ulatowski, 1979, p.1). Second, if the loan is nonrecourse, there is no impact on the face of the balance sheet of the sponsor. Even if the sponsor undertakes the completion guarantee, the sponsor can avoid any impact on his balance sheet after the period of construction (Nevitt, 1979, p.15). Third, the sponsor may share the project risk with lenders. A joint venture which is newly established for a project can obtain borrowing money through project financing (Tinsley, 1981, p.218). A joint venture is very common in international mineral developments because of the regulation of a host country or for tax purposes.

There are several distinctive features between project financing and ordinary loans (Wynant, 1980, p.166). Project financing usually depends heavily on leverage, and the debt is directly related to the project itself. All the risks of the loan are not backed up by the sponsors or by mortgages. And, the author thinks, an ordinary loan is a ready-made type loan, but a project finance is a hand-made type. Banks should consider a combination of credit structure and other considerations of the project, such as the right debt-equity ratio and market analysis, so that all interested parties are satisfied, especially the bankers' perception of risk.

2-2 Project Risk

Mining ventures themselves have several risks, as follows:

i. Geologic Risk

This risk includes reserve risk. Reserve estimation is a very important factor in project financing. It is reserves that are the original sources of cash flow. Usually banks take into account only proven reserves half of which should remain after the payout of loans (Tinsley, 1981, p.218).

ii. Market Risk

It is generally very difficult to forecast mineral prices; however, a long-term sales contract is often one of the distinctive features of a coal-mining project. Banks customarily should require contract terms longer than the period of the loan and consider if enough price escalation is included to cover increases in operating costs. This escalation requires sophisticated use of several indices which will reflect the increases of various components of operating costs (Moyer, 1980, p.73). A long term sales contract is a very effective tool in reducing marketing risk, but a lending institution should always consider contract conditions in addition such as amount and quality very carefully.

iii. Technological Risk

It can be argued that banks are typically risk averters, and tend to avoid new or not-established technologies especially in the case of a nonrecourse loan. Preference is given to established technologies in projects for possible investment.

iv. Political Risk

For foreign projects, banks should consider political country risks, as historically, some projects have failed because of such risks; e.g., Anaconda's Chilean project. Many political risks exist today within foreign projects; for example, pollution control requirements and other regulations can delay the project schedule and/or decrease the productivity of the project, resulting in insufficient cash outflows for repayment of a loan. Royalties and taxes, such as a state severance tax, are also very important considerations which can influence the outcome of the project.

v. Natural Risk

A mining venture is operated in nature, so it is taken for granted that the operating days of a mining business will be influenced by such natural risk as earthquake and flood.

Project risks clearly include the risks described above, but, in addition, they have the following risks:

vi. Cost Overrun risk (Capital Expenditure, Operating Cost)

This risk comes from inflation, poor engineering-design studies, and so on, and it is often seen in recent projects (Wyant, 1980, p.167). We may see the term "contingency" used in the cost estimation part of engineering reports. Actually, "contingency refers to those costs which are regulary encountered but cannot be tied down at the study stage" (Mining Engineering, 1978, p.1647). Moreover, it is recommended that banks should use the most conservative reserve estimation and the highest capital and operating cost estimate to analyse the project for the worst case (Beeder, 1981, p.225).

vii. Completion Delays

Completion delays were commonly seen in project financing, as well as cost overruns (Castle, 1975, p.16). This risk may be covered by the sponsor's agreeing to a completion guarantee; but this will produce a different cash flow from original projections.

viii. Foreign Exchange Risk

The foreign exchange market is, almost by definition, hard to forecast; however, one effective way to avoid this risk is to use the same currency for borrowed money and for main income.

ix. Management Risk

This risk is a very basic type of risk. The bank should carefully consider the sponsor's mining experience and his ability to perform. Labor relations should always be a consideration as strikes in coal mining are a serious consideration for investment analysis.

As described above, project financing has a high risk level, and banking institutions should avoid taking on these types of projects alone, but should endeavor to convert them to sponsor and third party as much as possible.

Finally, it is said that most major companies in the United States can afford to finance new coal-mining projects internally (U.S. Department of Energy, 1981b, p.33). Bankers, therefore, may encounter more marginal projects or sponsors with relatively poor credit. This situation lends further support to the requirement for carefully analysed project investment decisions.

3. OUTLOOK OF THE COAL MARKET

3-1 Distinctive Features of Coal

"Coal is defined as a combustible rock that originated in the accumulation and physical and chemical alteration of vegetation" (Simon and Hopkins, 1981, p.14). Simply speaking, coal is a black rock that burns.

Several methods of classifying coal have been developed. The standard classification of American coal is by rank, developed by the American Society for Testing and Materials. The basic classes are shown in Table 1. In the high-ranked coals, ranks are determined by the fixed carbon content on a dry basis. The lower ranked coal are classified by their heating value. Generally the coals between low-volatile bitiminous coal and high-volatile bitiminous coal are considered metallurgical coals.

A Btu is the amount of heat required to raise one pound of water one degree Fahrenheit. Steam coal is sold on the basis of cost/million Btu.

Example: 10,000 Btu x 2,000 lb = 20,000,000 Btu/Short Ton

If the cost/short ton is $20.00, then the cost/million Btu = $20/20 = $1.00/million Btu's.

Thus, when we look at steam-coal price per ton it does not reflect true costs, so we must take into account the heating value per ton.

TABLE 1

Classification of Coal by Rank

Class	Group	Agglomerating Character
I. Anthracite	1. Meta-anthracite 2. Anthracite 3. Semianthracite	Nonagglomerating
II. Bituminous	1. Low-volatile bituminous coal 2. Medium-volatile bituminous coal 3. High-volatile A bituminous coal 4. High-volatile B bituminous coal	Commonly agglomerating
	5. High-volatile C bituminous coal	Agglomerating
III. Subbituminous	1. Subbituminous A coal 2. Subbituminous B coal 3. Subbituminous C coal	Nonagglomerating
IV. Lignite	1. Lignite A 2. Lignite B	

Source: American Society for Testing and Materials, D 388, quoted in Simon and Hopkins (pp. 26-27)

Quality of coal is also a very important factor. The coal containing between 12.5% and 25.0% ash-plus-sulfur can cause incremental utilization costs ranging from less than $1.00 to more than $8.00 per ton of coal, when combusted in a pulverized coal fired power plant (Phillips and Cole, 1979, p.297).

Coal by itself has a dirty image. It takes a long time to get public acceptance in order to develop coal mines. Such mines are faced with severe Government regulations, and these regulations are very critical factors to the coal mining business. Labor productivity of coal mining in the United States is shown in Table 2. In 1977, the Clean Air Act Amendments (PL 95-96) and the Surface Mining Control and Reclamation Act (PL 95-87) were enacted. It can be argued that these laws accelerated the decline of labor productivity in coal mining.

Generally, compared with oil, steam coal has some disadvantages: transportation and combustion problems, and disposal of ash. For example, obviously transportation of coal is more expensive than that of oil because coal is a solid fuel. Concerning the structure of CIF price it can be estimated that 60-80 percent of coal prices are FOB prices; the rest are transportation costs and insurance. On the other hand, 90 percent of oil prices are FOB prices.

TABLE 2

Labor productivity of coal mining in the U.S.

Unit; Short ton /man day

YEAR	UNDERGROUND	SURFACE
1950	5.75	15.66
1955	8.28	21.17
1960	10.64	23.31
1965	14.00	32.76
1970	13.76	36.26
1975	9.54	26.69
1977	8.69	26.59
1978	8.38	25.78
1979	7.90	24.80
1980	9.00	27.75

Source:U.S. Department of Energy Annual Report to Congress 1980, Vol.2

3-2 Japanese Government Energy Policy

Japan is the largest coal importing country (MITI, 1979, p.314), mostly for metallurgical purposes. Nowadays, however, steam coals are gaining more attention as energy sources. Most power sources in Japan depend upon imported energy. Japanese dependence on imported energy in 1979 was 85.7%, and the dependence on imported oil was 99.8%. According to Table 3, the dependence on imported energy of Germany and France were 56.9% and 75.8%, respectively, and their dependence on imported oil were 96.7% and 99.0% respectively. This means that a special characteristic of Japan's energy-supply structure is a heavy emphasis on oil (Figure 1).

It is a very important policy of Japan to obtain a stable supply of energy for the purpose of maintaining the development of the economy and stable living conditions for the people. Japanese energy policy is based on the following three guidelines: (ANRE, 1981, p.12)

i. Promotion of energy conservation;

ii. Promotion of the development and introduction of nuclear power, coal, natural gas, and other alternative energy sources; and

iii. Securing stable oil supplies

Based on these three guidelines are seven basic policies (MITI, 1979, pp.53-55):

a. Advertise and execute an energy conservation policy

TABLE 3

Dependence on Imported Energy (1979)

	Dependence on Imported Energy (%)	Dependence on Imported Oil (%)
Japan	85.7	99.8
Germany	56.9	96.7
U.K.	12.1	15.4
France	75.8	99.0
Italy	82.3	98.2
U.S.A.	18.6	44.1

Source: OECD Energy Balances, quoted in ANRE(p.6)

TABLE 4

Coal Imports by Sources

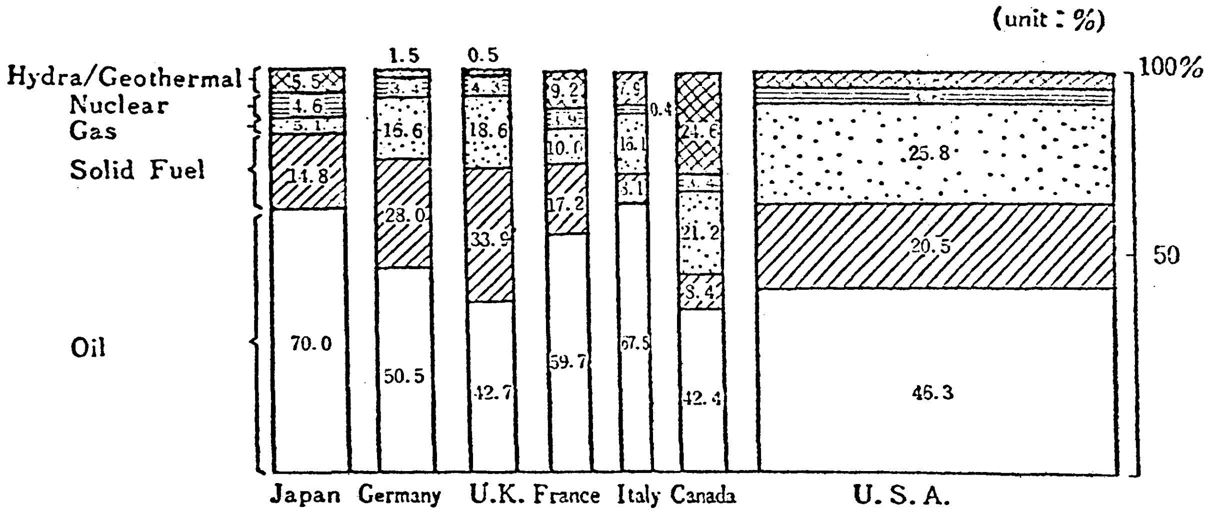
Unit: thousand ton

	FY1977		FY1979		FY1980	
	Coking	Steam	Coking	Steam	Coking	Steam
U.S.A.	13150	-	13987	-	20775	709
Canada	10600	-	9777	-	11145	600
Australia	26040	553	27013	1287	26303	4272
U.S.S.R.	2850	216	1932	124	2009	245
China	-	170	840	239	958	760
Others	3280	9	3111	25	3328	521
Total	55920	948	56660	1675	65418	7107

Source: MITI, quoted in ANRE (p.22)

FIGURE 1

Primary Energy Supply Patterns(1979)



Source :OECD Energy Balances, quote in ANRE, p.6

for the people;

b. Use domestic resources effectively;

c. Make an effort to develop and introduce alternative energy sources than oil in order to decrease the dependence on oil resources;

d. Diversify the suppliers (countries) of energy resources;

e. Stockpile energy resources to prepare for an energy crisis;

f. Construct a smoothly functioning infrastructure; and

g. Develop new technologies which can solve the many energy problems.

As described above, Japan is attempting to develop alternatives to oil, particulary coal. There are four major policies regarding coal:(ANRE, 1981, p.22)

i. Development and importation of overseas coal resources will be encouraged, while domestic production will be maintained at about the present level (20 million tons)

ii. Construction of coal-fired thermal power stations will be encouraged

iii. Investment needed for the conversion to coal burning facilities will be encouraged

iv. Efforts will be made to participate in development projects in coal-producing countries and to build up the necessary infrastructure.

These policies aim to obtain stable supplies of coal and to expand the demand for coal.

Table 4, Figure 2, and Figure 3 describe the supply and demand for coal in Japan. Obviously the coking coal (metallurgical coal) for the iron & steel industry occupies a large portion of demand. We also can easily see the increase in imported steam coal.

The Research Committee of General Energy (one of the Government's committees) projected the demand for coal (in million of tons) in Japan as follows (August 31, 1979): (ANRE, 1981, p.27)

	1977	1985	1990	1995
Total Import Coal	58.29	101.00	143.5	178
(Steam Coal)	(.95)	(22)	(53.5)	(80.5)

As described above, the Japanese Government is planning on coal as an important alternative to oil as an energy resource.

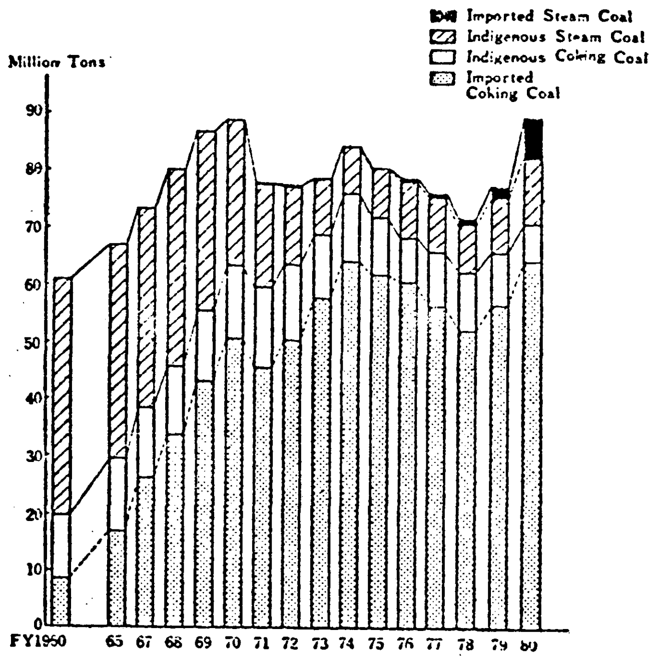
3-3 Supply and Demand

a. Reserves

According to the World Energy Conference (1978), total reserves, which are technically and economically recoverable reserves for hard coal and for brown coal, are about 636

FIGURE 2

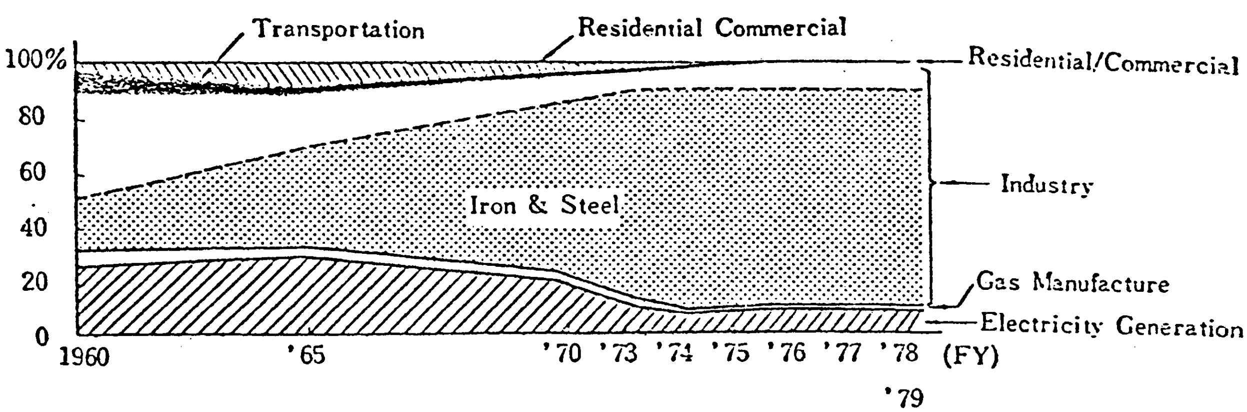
Coal Supply in Japan



Source;MITI, quote in ANRE, p.22

FIGURE 3

Coal Demand in Japan



Note:after ANRE, p.23

billion tons (Table 5). Compared with an actual world production in 1977 (3.4 billion tons), these abundant reserves indicate about 190 years' production.

The outstanding feature of the distribution is the fact that the Big Three possess 60.7 percent of the world's reserves; the United States with 27.9 percent, the U.S.S.R. with 17.3 percent, the Peoples Republic of China with 15.5 percent. The top ten countries contain about 90 percent of the world reserves. However most of these ten countries, such as the United States, Canada, Australia, and Western European countries, are more stable politically and economically than such oil suppliers as the Mid-East countries.

b. Projection of Supply and Demand

An increase in coal demand is expected by several forecasts by different countries and different institutions. In mid-1980, the World Coal (WOCOL) Study- an international study project with over 80 participants from 16 coal producing and consuming countries- named coal as a "bridge to the future". World coal production was predicted to rise 2.5 to 3 times between 1977 and 2000 in order to balance world energy demands (Horwitch, 1980, p.95). The leaders of seven industrialized nations at an economic summit meeting in Venice in June, 1980, declared that they intended to double both coal production and consumption by 1990. This long term forecast of coal demand conducted by WOCOL can be seen in Table 6.

TABLE 5

Ranking of Countries by Their Coal Reserves, 1978

unit: Billion Tons (TCE)*

Rank	Country	Hard Coal	Brown Coal	Total Coal Equivalent	Ratio
					%
1	United States	113.2	64.4	177.6	27.9
2	U.S.S.R.	82.9	27.0	109.9	17.3
3	P.R. of China	98.9	N.A.	98.9	15.5
4	United Kingdom	45.0	-	45.0	7.1
5	F.R. Germany	23.9	10.5	34.4	5.4
6	India	33.3	0.4	33.7	5.3
7	Australia	18.1	9.2	27.3	4.3
8	South Africa	26.9	-	26.9	4.2
9	Poland	20.0	1.0	21.0	3.3
10	Canada	8.7	0.7	9.4	1.5
	Others	21.6	30.7	52.3	8.2
	(Japan)	(1.0)	(0.0)	(1.0)	(0.2)
	Total	492.5	143.9	636.4	100.0

Source: London World Energy Conference 1978: Survey of Energy Resources

* Tons of coal equivalents (TCE) are based on the total actual contained heat content of the material in question, adjusted to 7000 kilocalories/kilogram (12600 BTU/Lb.).

TABLE 6

Long-term Projection of Coal Demand Among O.E.C.D. Countries

	1977	1985		2000	
	actual(%)	Low (%)	High (%)	Low (%)	High (%)
Steam Coal	740 (74.7)	950 (76.9)	1075 (78.5)	1670 (83.5)	2650 (87.6)
Electric Power Generation	600 (60.6)	800 (64.8)	880 (64.2)	1325 (66.3)	1850 (61.2)
Industrial & Other	140 (14.1)	150 (12.1)	195 (14.3)	345 (17.2)	800 (26.4)
Metallurgical	250 (25.3)	285 (23.1)	295 (21.5)	330 (16.5)	375 (12.4)
Total	990 (100.0)	1235 (100.0)	1370 (100.0)	2000 (100.0)	3025 (100.0)

In the United States, the 1981 Annual Report to Congress (U.S. Department of Energy) describes coal as follows:

> Coal consumption is projected to increase ... at an average annual rate of 3.8 percent. Although oil will continue to be the major source of energy in the free world, 13 percent of the growth in total energy consumed from 1979 to 1995 is projected to come from gas, 47 percent from coal, 23 percent from nuclear and 11 percent from all other sources of energy because of oil's growing scarcity and rising price. (Figure 4)

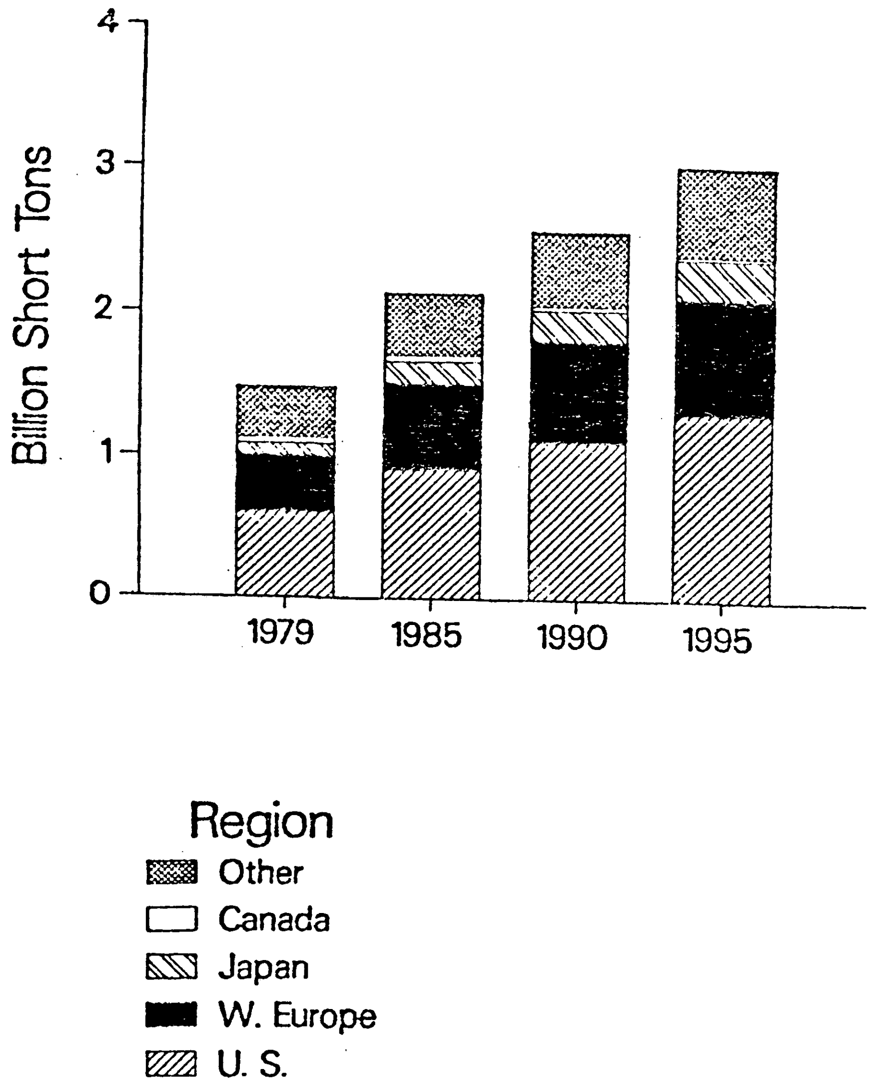
From a short-term viewpoint, the coal business does not look good due to recent oversupplies in the United States and the decline of oil prices. This author thinks that the immediate future of coal depends mainly on the fear of a shortage of oil supplies and on the raising of oil prices. Today, however, oil prices are not rising, and the strength of OPEC countries seems to be declining because of the recession of the world economy, the increase in oil production in such non-OPEC countries as Mexico and England, and the increased acceptance of energy conservation policies. We would argue that the above consideration dim any bright future for coal. It is extremely difficult to predict the future of coal under today's politically and economically complicated conditions.

3-4 Price

There are two different types of prices in coal market-contract prices and spot prices. Historically, spot prices and contract prices have moved, roughly, together. To be

FIGURE 4

Free World Consumption of Coal by Region and Country



Note: One short ton of coal is equivalent to approximately 22,500,000 Btu.

Source: Historical data: U.S. Department of Energy, Energy Information Administration, 1980 International Energy Annual, quoted in 1981 Annual Report to Congress, Vol. 2, p.124.

sure, spot prices fluctuate widely compared with contract prices (Schmidt, 1979, p.416), and spot prices are usually higher than contract ones. Seventy percent of the production of the particular project analysed later is based on a long-term sales contract.

Figure 5 shows the comparison of prices among several mineral fuels in the United States. Obviously coal prices went up in 1974 along with oil prices, but they never reached Btu equivalency with oil. Since the investment cost of coal utilization in industrial markets is two to three times that of oil or gas utilization (The President's Commission on Coal, 1979, p.96), the difference in price between oil and coal is the necessary condition for the development of coal.

Several factors are considered as coal price determinants.

i. Geology

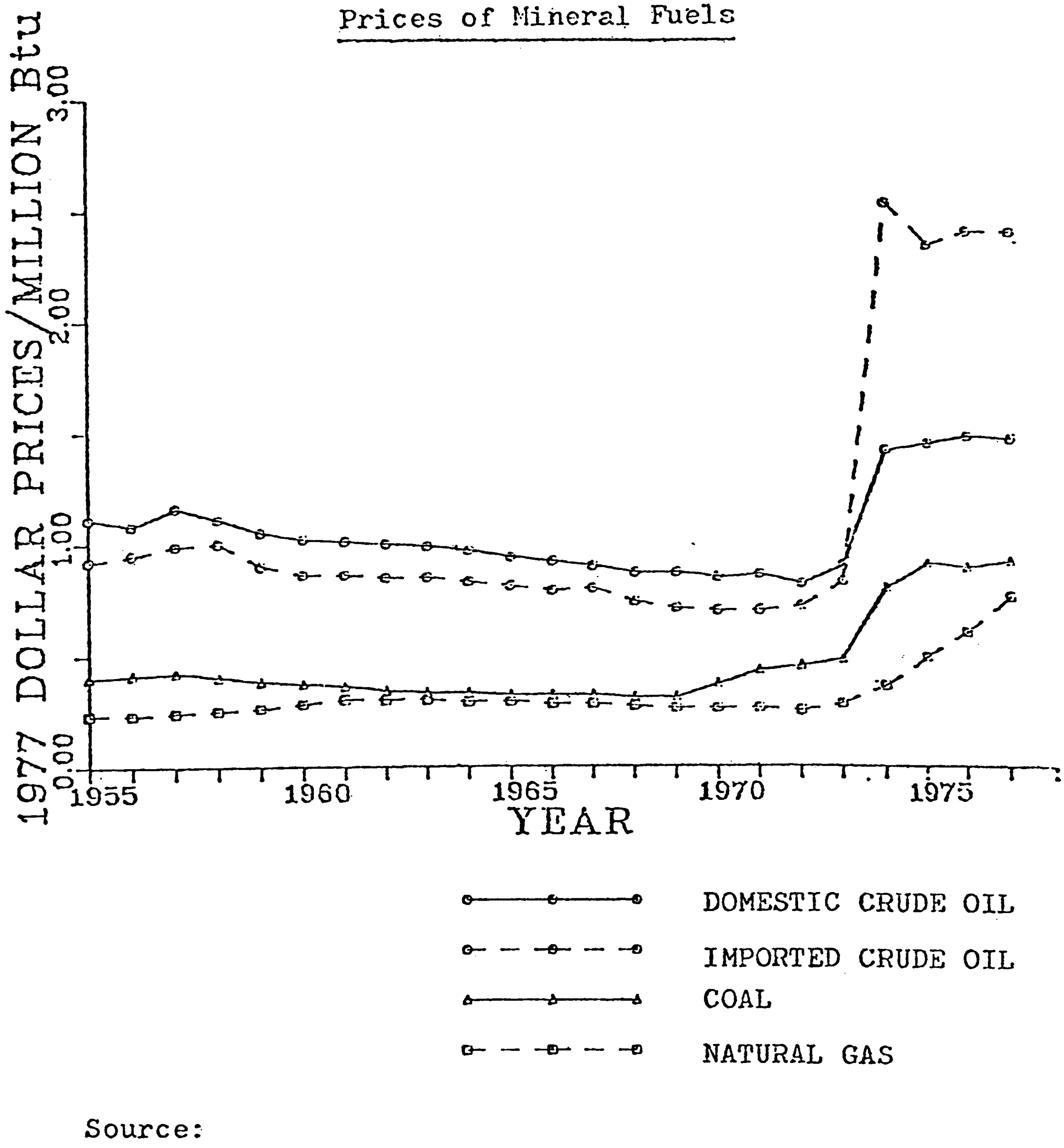
Thick coal seams are easier to mine by underground methods because of lower capital costs and higher productivity. Near surface strippable coal is cheaper to mine.

ii. Method of Mining

Underground mining is generally more expensive than surface mining. However, new surface mine reclamation requirements have increased the cost of surface mining.

FIGURE 5

Prices of Mineral Fuels



Source:

Bureau of Mines and Energy Information Administration:
1977 Annual Report to Congress, Vol.III,
quoted in The President's Commision on Coal (p.97)

iii. Labor

The general decline in labor productivity has contributed to increased coal prices.

iv. Coal quality and markets

Higher coal quality, production of metallurgical-grade coals, and closeness to the major markets are, naturally, preferrable.

As mentioned before, the price of coal is a very critical factor. The bank should examine the projected prices of each project, whether conservative or not, considering each particular characteristic of the coal.

4. BASE CASE

4-1 Description

The project evaluated in this thesis is a surface coal mining project, in an area well served for infrastructure. The project is in Australia, so all economic evaluation will be done using Australian taxes. In addition to rail and highway access, the area is well provided with other essential services such as power, water, and social infrastructure. The area is also close to a port which is accessed by an existing double track railway.

The climate in the project area is pleasant with average maximum temperatures ranging from 10.7°C to 23.2°C and minimum temperatures ranging from 5.1°C to 16°C. Average annual rainfall is 650 mm.

Estimated reserves of in-situ coal are 172 million tons for the whole lease area. The reserve estimates have been confirmed by internationally reputable geologic consultants. Taking into account density, mining recovery, and washery yield, recoverable reserves for open pit mining are assessed as 74 million tons and saleable coal as 59 million tons.

The quality of coal is thermal coal, being high in calorific value, low in sulfur, and within acceptable limits in other characteristics.

The seams have working thickness ranging from 1.5 to 5.0 meters and occur over a stratigraphic interval of 100 to 120 meters. The inter-seam strata are composed mainly of sandstone, siltstone, and mudstone, with sandstone comprising about 60% of the total. Exploration has revealed no evidence of igneous intrusion and any faulting which may be present is not on a sufficiently large scale to influence the mine design or seriously affect operations.

The stripping ratio increases from approximately 6 in the first five years up to 7 from year ten on and does not increase substantially until the final years of the project when the ratio would limit the mine life on current economic parameters.

The mine is planned as a deep multi-seam open pit with the initial box cut in the southeast corner. Overburden removal is by shovel and truck initially, with a dragline planned to remove the lower interburdens once the full depth of the pit has been reached. At full production, the main equipment will consist of three mining shovels, one dragline, front end loaders, overburden trucks, coal trucks, and the necessary support equipment.

The first clean coal shipments are scheduled in 1983. At full production, about 2.8 million tons of saleable coal will be produced, and 2.0 million tons of these will be exported to Japan under long-term contract.

Capital expenditure (excluding working capital) from 1982 to 1998 is expected to be $516.8 million ($293 million in the same period as withdrawal of the loan), and a loan of $273.5 million is proposed to the banks. Other parts of the capital expenditure and costs for daily operations will be covered by internal cash flows and equities. US dollars are used in this thesis; however, the actual operation uses local currency.

4-2 Data and Assumptions

Table 7 indicates the capital expenditure and the working capital. The capital expenditure includes a 10% contingency. The working capital consists of inventories, accounts receivable and accounts payable, and so forth.

The forecast of the saleable coal, which is projected by a joint venture (JOVE), is shown in Table 8. As mentioned before, the total saleable coal is estimated as 59 million tons. Total saleable coal up to 1995 (loan period) is about 29.5 million tons. Thus, when the loan is projected to pay out, half the saleable coal will still remain. According to the minimum criteria of Chemical Bank, at the time the repayment of the loan is finished, at least half the reserves must remain (Castle, 1975, p.20).

The average current coal price in this area is $48.74 per ton FOB in 1981 terms under long-term contract. The price has two components, such as FOR price at the mine and infrastructure and government charges. Seventy percent of

TABLE 7

Forecast of Capital Expenditure and Working Capital

unit: million dollars

Year	Capital Expenditure	Working capital
1982	19.2	
1983	133.8	
1984	63.7	3.4
1985	41.3	20.9
1986	54.2	4.0
1987	0.9	1.7
1988	0.9	-3.6
1989	11.9	3.1
1990	2.8	3.4
1991	14.8	2.8
1992	15.5	4.0
1993	23.0	4.5
1994	26.6	4.1
1995	37.0	4.2
1996	28.9	5.6
1997	40.0	
1998	2.3	14.4

TABLE 8

Forecast of Production and Royalty

Year	Production(million tons)	Royalty(million dollars)
1982	0	
1983	0	
1984	0.3	1.4
1985	1.6	8.3
1986	2.4	13.7
1987	2.6	15.8
1988	3.1	20.7
1989	2.8	20.2
1990	2.8	21.7
1991	2.8	23.4
1992	2.7	24.8
1993	2.8	26.8
1994	2.8	29.5
1995	2.8	32.3
1996	2.8	34.2
1997	2.7	36.0
1998	2.8	40.3

1984-1995 (total)	29.5
total estimated saleable coals	59

the former cost and a hundred percent of the latter cost (including royalty) are covered by the sale price under the sales contract.

The forecast of price, which is projected by JOVE, is shown in Figure 6, which also indicates other coal price forecasts conducted by major institutions. According to Figure 6, the forecast of JOVE was moderate compared with other forecasts projected at that time.

The sales contract between buyer and seller fixes the prices (plus escalation) for periods up to about two years, but the base price for each contract period will be greatly affected by prevailing market conditions at the time of negotiations. Moreover, these forecasts might not take into account the recent decline of oil price even if this phenomenon might be transient. Therefore, the sensitivity analysis for price becomes more important, and this analysis will be shown in the latter chapter.

The operating cost, which includes all deductable costs except depreciation, another capital allowance, and interest (leveraged case), is shown in Table 9. The depreciation and another capital allowance are also shown in Table 9 separately. Operations have been planned for 220 days per year which allows for national holidays, weekends, and a provision for lost time due to wet weather and strikes. The lost time, for weather and strikes combined, of fifteen

FIGURE 6

Forecast of Coal Price

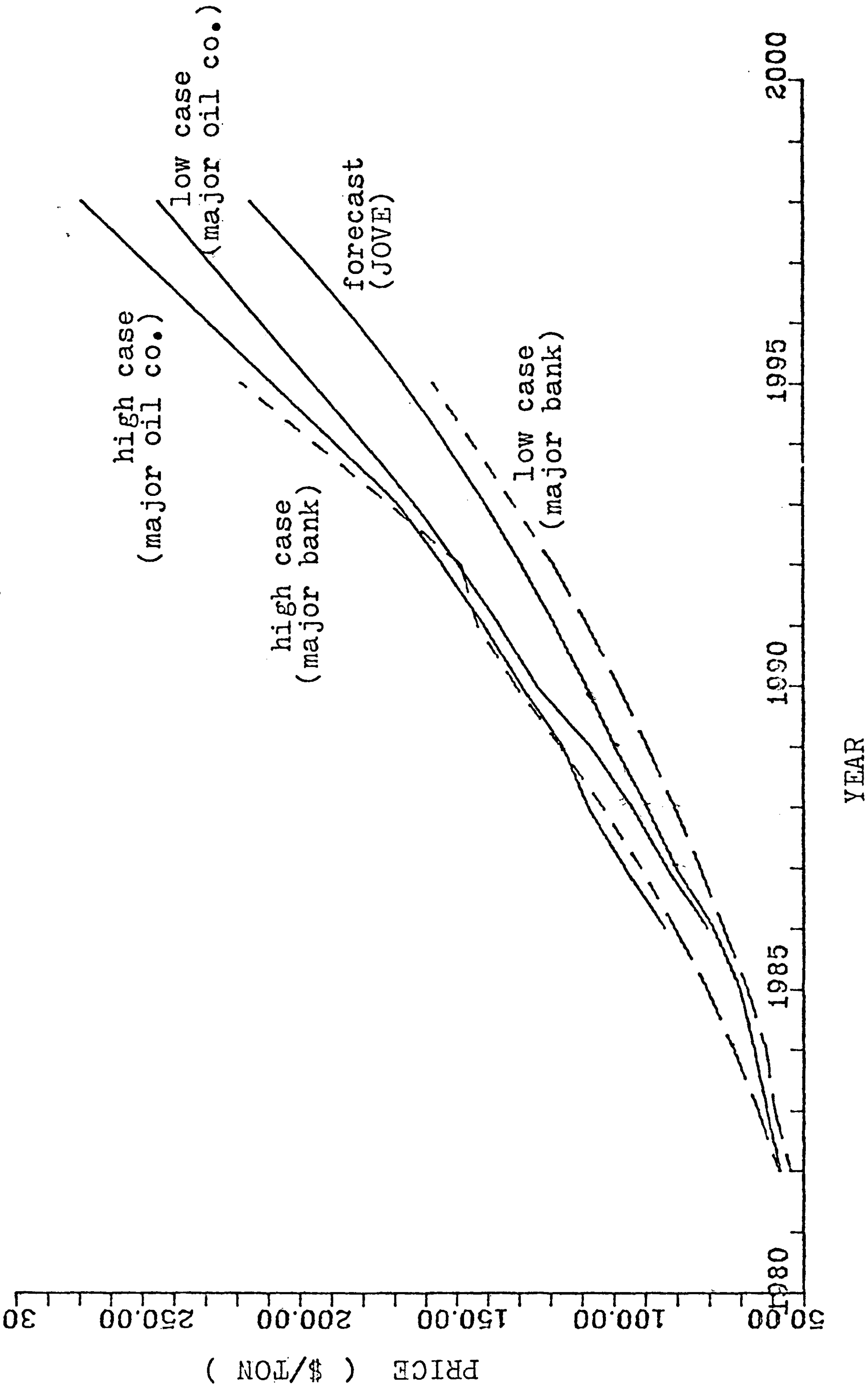


TABLE 9

Forecast of operating cost, depreciation and capital allowance

unit: million dollars

Year	OP.cost	Depreciation	Allowance
1982	0.5		0.6
1983	2.1	6.0	14.7
1984	14.3	10.1	6.9
1985	78.3	16.9	10.3
1986	114.7	21.6	12.8
1987	127.1	16.5	
1988	169.4	12.6	
1989	171.7	39.2	
1990	189.1	27.2	
1991	202.2	26.7	
1992	222.9	26.4	
1993	244.3	27.8	
1994	264.9	29.6	
1995	286.3	33.4	
1996	313.7	33.9	
1997	286.9	37.9	
1998	344.2	30.8	

days is considered to be realistic based on the experience in this area over the last few years. The depreciation rates vary according to the type of assets; ten to twenty-seven percent annual depreciation is taken, based on a declining balance. The capital allowance in this thesis looks like the Investment Tax Credit in the United States. There is no depletion allowance in this project as a method of capital allowance.

The income tax rate is 46 percent. There is no other income tax to JOVE which only operates the project.

The figures of the forecast of price and cost are given in current dollars. This means that the forecasts have already taken into account cost escalation and inflation effects.

This thesis uses US dollars but actual operations use local currency, therefore it is advisable to forecast the foreign exchange market. This thesis, however, did not do so because exchange rates have been changing so drastically that any forecast would be somewhat useless (Takezaki, 1981, p.13). The exchange rate problem will be discussed in Chapter 6.

JOVE expects the loan in this project to be withdrawn according to the following schedule: in 1983, $138.7 million; in 1984, $71.2 million; in 1985, $30.0 million; in 1986, $33.6 million. The repayment of the loan is also expected according to the following schedule: from 1987 to 1994, $29.6 million per year; in 1986, $37.0 million. The interest rate is assumed to be fixed at 12 percent annually throughout the loan period.

All of the cash flow for this project is assumed to occur at the end of the year for economic evaluation purpose. It is true that all of the cash flow does not occur at the end of the year, but this method is generally accepted around the world for investment decision methods. Net Present Value (NPV) is calculated at a 20 percent minimum Rate of Return (ROR).

The analysis evaluates seventeen years of the project life which is actually longer than the loan life. It is preferable for the bank forecast of cash flow to extend through the life of proposed loan plus some additional years because it is possible that the repayment of the loan will be postponed (Mining Engineering, 1978, p.1648). In this case the loan is expected to be repaid within fourteen years from the beginning of the project.

5. ECONOMIC EVALUATION

5-1 Review of the Methods

When a bank lends money, repayment of the loan is the most important concern of the bank. In the case of project financing, a project needs enough net annual cash flow to cover the payout of the loan. This is only a necessary condition for the company and is not a sufficient condition. The project has to be profitable for the company.

Methods for assessing profitability to be considered in this thesis are the discounted-cash-flow rate-of-return (DCFROR) method and net-present-value (NPV) method. There are some advantages and disadvantages in these methods. Both DCFROR and NPV are based on discounted cash flows. It is generally accepted that $100 at present is more valuable than $100 in the future. Therefore, both DCFROR and NPV are considered to be superior to other conventional methods such as accountant rate of return because they consider the time value of money while other conventional methods do not. As DCFROR indicates a single percentage, it is easily understood; it does not need consideration of a discount rate. The NPV method can express the accumulated NPV in each year at a discount rate. Then, when the bank has some standard for a favorable accumulated NPV at a discount rate, a project with a favorable NPV in early years is a good one. The DCFROR method may do the same thing if the times to reach considered values of DCFROR are determined. The shorter the time, the more preferable the project.

Before proceeding to another method, the disadvantage of both methods has to be mentioned. The cash flow data, involving cost estimation and price forecasts, are not always accurate. There is a trade-off between accuracy and cost. The banks should require accurate data, so they often demand data which are estimated by a well-known independent engineering company. Compensating for this disadvantage, it is suggested that sensitivity analysis or computer simulation should be done. Several such sensitivity analyses are made in the latter part of this chapter.

Concerning the NPV method, a discount rate has to be determined before an evaluation is made. This rate is often referred to as a minimum rate-of-return (ROR). From a banking viewpoint, it is accepted that the cost of capital plus the allowance for risk is a minimum ROR (Stermole, 1980, p.64). The cost of capital for most companies ranges between 10 and 15 percent (Weston and Brigham, 1977, p.296). Therefore, 20 percent is used as the minimum ROR in this thesis.

Next, the payback period criterion is considered. This method cannot measure the profitability of a project but is useful as a risk indicator. There are several objections to this method. One is that it ignores the time value of money. Another is that the maximum payback period is a kind of magic number, and a decision maker knows only that number. Still another is that it ignores the cash flow after the payback period.

Nevertheless, sixty-one percent of the large corporations surveyed in Rosenblatt and Jucker, 1979, p.67, use the payback-period criterion as a risk indicator since the method is very simple and easy to calculate. This author thinks that simplicity and ease are very attractive features for any decision criteria. Mining companies are relatively involved in risk so they need protection against it. Finally, the payback-period criterion represents a break-even point. The longer the payback period, the higher the chance of loss. In other words, the shorter the payback period, the higher the degree of reliability.

5-2 Cash Flow Analysis

This project makes use of borrowed money, but the all-cash investment case should be examined because the borrowed money makes the project look better (Stermole, 1980, pp.320-321). The bank should avoid a marginal and/or unprofitable project which looks better because of leverage effects.

Table 10 shows the cash flow for the all-cash case. Cash investment DCFROR is 16.0 percent. The NPV for this

TABLE 1C

Cash Flow - All-cash Case

CASH FLOW TABLE UNIT:$MILLION

END YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
REVENUE	0.0	0.0	18.9	111.5	189.2	233.3	310.9	308.5	333.3
-ROYALTY	0.0	0.0	1.4	8.3	13.7	15.8	20.7	20.2	21.7
-OP. COST	0.5	1.3	13.9	78.1	114.6	127.1	169.4	171.7	189.1
-INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-DEPRECI.	0.0	6.0	10.1	16.9	21.6	16.5	12.6	39.2	27.2
-ALLOWANCE	0.6	14.7	6.9	10.3	12.8	0.0	0.0	0.0	0.0
-CARRY LOS	0.0	0.0	0.0	0.0	26.5	12.1	0.0	0.0	0.0
TAXABLE IN	-1.1	-22.0	-13.4	-2.1	0.0	61.8	108.2	77.4	95.3
-TAX@46.0%	0.0	0.0	0.0	0.0	0.0	28.4	49.8	35.6	43.8
NET INCOME	-1.1	-22.0	-13.4	-2.1	0.0	33.4	58.4	41.8	51.5
+DEPRECI.	0.0	6.0	10.1	16.9	21.6	16.5	12.6	39.2	27.2
+ALLOWANCE	0.6	14.7	6.9	10.3	12.8	0.0	0.0	0.0	0.0
+CARRY LOS	0.0	0.0	0.0	0.0	26.5	12.1	0.0	0.0	0.0
+BORROWING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-REPAYMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-CAP.EXP.	19.2	133.8	63.7	41.3	54.2	0.9	0.9	11.9	2.8
-WORK.CAP.	0.0	0.0	3.4	20.9	4.0	1.7	-3.6	3.1	3.4
N.C.F.	-19.7	-135.1	-63.5	-37.1	2.7	59.4	73.7	66.0	72.5

TABLE 10 (continued)

CASH FLOW TABLE UNIT:$MILLION

END YEAR	1991	1992	1993	1994	1995	1996	1997	1998
REVENUE	359.9	382.2	416.1	459.2	503.8	533.9	564.4	634.6
-ROYALTY	23.4	24.8	26.8	29.5	32.3	34.2	36.0	40.3
-OP. COST	202.2	222.9	244.3	264.9	286.3	313.7	286.9	344.2
-INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-DEPRECI.	26.7	26.4	27.8	29.6	33.4	33.9	37.9	30.8
-ALLOWANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-CARRY LOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAXABLE IN	107.6	108.1	117.2	135.2	151.8	152.1	203.6	219.3
-TAX@46.0%	49.5	49.7	53.9	62.2	69.8	70.0	93.7	100.9
NET INCOME	58.1	58.4	63.3	73.0	82.0	82.1	109.9	118.4
+DEPRECI.	26.7	26.4	27.8	29.6	33.4	33.9	37.9	30.8
+ALLOWANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+CARRY LOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+BORROWING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-REPAYMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-CAP.EXP.	14.8	15.5	23.0	26.6	37.0	28.9	40.0	2.3
-WORK.CAP.	2.8	4.0	4.5	4.1	4.2	5.6	0.0	14.4
N.C.F.	67.2	65.3	63.6	71.9	74.2	81.5	107.8	132.5

case at several discounting rates is shown in Table 11. The payback period is 5.74 years. The cash flow for the leveraged case which is offered by JOVE is shown in Table 12. Leveraged DCFROR is 32.0 percent. The NPV for this case is also shown in Table 11. The NPV is $42.3 million at the 20 percent minimum ROR. The payback period is 3.54 years. The relationship between rate of returns (ROR) and NPV of both cases are shown in Figure 7. The intersection with the X-axis indicates the DCFROR in each case.

According to Table 10, the all-cash case will produce positive annual cash flows after 1986. Between 1982 and 1985 negative annual cash flows will be produced mainly because of large capital expenditures. In 1986 especially, the net income will be zero due to use of carry loss forward; but the annual cash flow will be positive ($2.7M) despite the large capital expenditure (54.2M) because several deductions, such as depreciation, are made.

On the other hand, Table 12 indicates that the leveraged case will also yield positive annual cash flows after 1986. However, there are two differences in the cash flow table for the leveraged case as compared with that of the all-cash case. One is that the annual cash flow of 1983 is positive although the all-cash case is not. The reason for this is that the amount of borrowed money is larger than the capital expenditure in 1983. The other is that the magnitude of the

TABLE 11

ROR/NPV Relationship

ROR(%)	NPV($M) All Cash Case	NPV($M) Leveraged Case
5	315.4	289.7
10	121.6	155.2
15	15.2	82.9
20	-45.1	42.3
25	-79.9	18.5
30	-100.1	4.0
35	-111.7	-5.0
40	-118.1	-10.9
45	-121.2	-14.8
50	-122.2	-17.3
55	-121.9	-19.1
60	-120.8	-20.2
65	-119.1	-21.0
70	-117.1	-21.6
75	-114.9	-21.9
80	-112.6	-22.1
85	-110.3	-22.2
90	-108.0	-22.3
95	-105.8	-22.3
100	-103.5	-22.3

TABLE 12

Cash Flow - Leveraged Case

CASH FLOW TABLE UNIT:$MILLION

END YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990
REVENUE	0.0	0.0	18.9	111.5	189.2	233.3	310.9	308.5	333.3
-ROYALTY	0.0	0.0	1.4	8.3	13.7	15.8	20.7	20.2	21.7
-OP. COST	0.5	2.1	14.3	78.3	114.7	127.1	169.4	171.7	189.1
-INTEREST	0.0	0.0	16.6	25.2	28.8	32.8	29.3	25.7	22.2
-DEPRECI.	0.0	6.0	10.1	16.9	21.6	16.5	12.6	39.2	27.2
-ALLOWANCE	0.6	14.7	6.9	10.3	12.8	0.0	0.0	0.0	0.0
-CARRY LOS	0.0	0.0	0.0	0.0	0.0	41.1	43.1	0.0	0.0
TAXABLE IN	-1.1	-22.8	-30.4	-27.5	-2.4	0.0	35.8	51.7	73.1
-TAX@46.0%	0.0	0.0	0.0	0.0	0.0	0.0	16.5	23.8	33.6
NET INCOME	-1.1	-22.8	-30.4	-27.5	-2.4	0.0	19.3	27.9	39.5
+DEPRECI.	0.0	6.0	10.1	16.9	21.6	16.5	12.6	39.2	27.2
+ALLOWANCE	0.6	14.7	6.9	10.3	12.8	0.0	0.0	0.0	0.0
+CARRY LOS	0.0	0.0	0.0	0.0	0.0	41.1	43.1	0.0	0.0
+BORROWING	0.0	138.7	71.2	30.0	33.6	0.0	0.0	0.0	0.0
-REPAYMENT	0.0	0.0	0.0	0.0	0.0	29.6	29.6	29.6	29.6
-CAP.EXP.	19.2	133.8	63.7	41.3	54.2	0.9	0.9	11.9	2.8
-WORK.CAP.	0.0	0.0	3.4	20.9	4.0	1.7	-3.6	3.1	3.4
N.C.F.	-19.7	2.8	-9.3	-32.5	7.4	25.4	48.2	22.5	30.9
DEBT COVERAGE RATIO	0.00	0.00	0.00	0.00	0.00	1.41	1.82	1.41	1.60

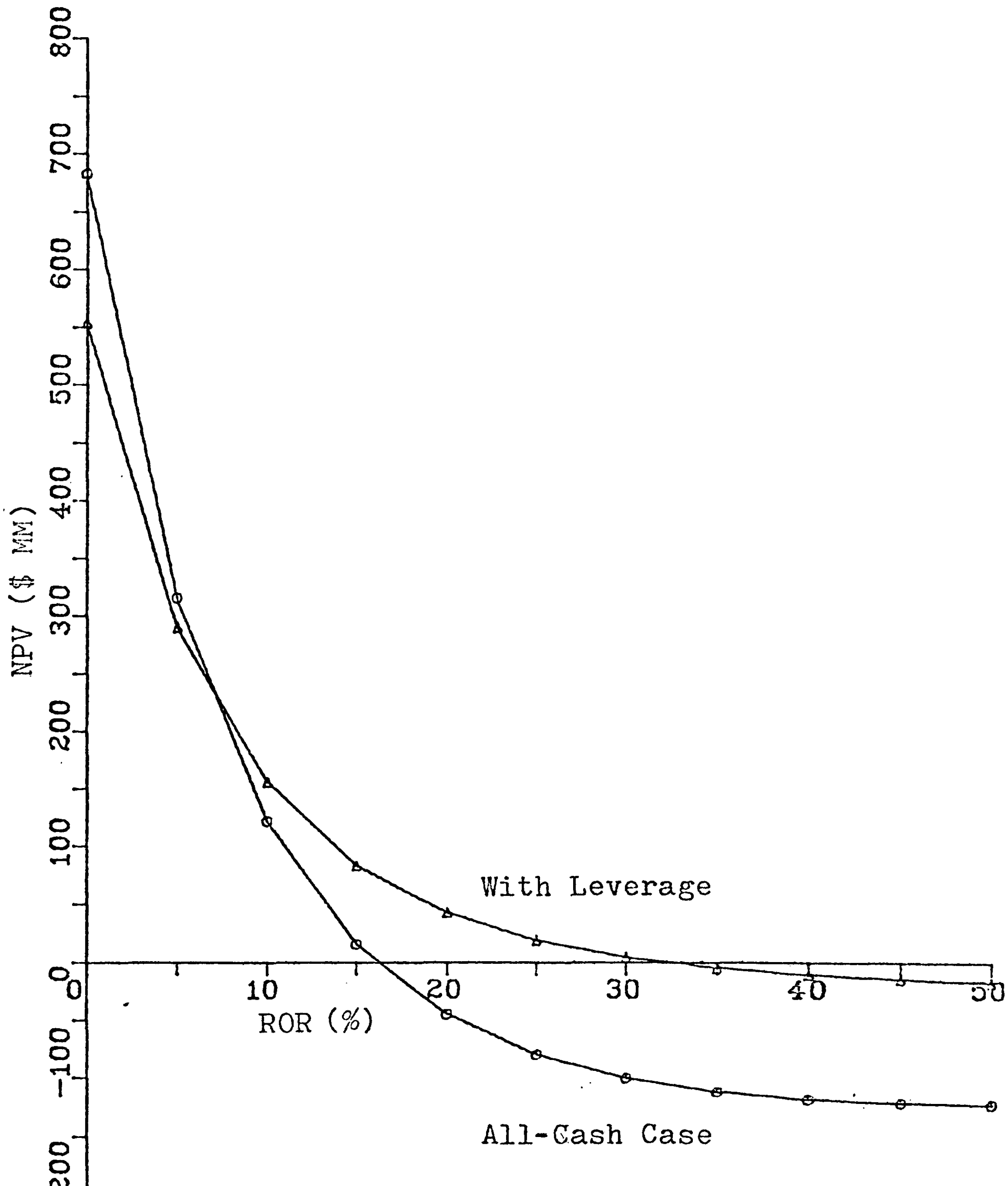
TABLE 12 (continued)

CASH FLOW TABLE UNIT:$MILLION

END YEAR	1991	1992	1993	1994	1995	1996	1997	1998
REVENUE	359.9	382.2	416.1	459.2	503.8	533.9	564.4	634.6
-ROYALTY	23.4	24.8	26.8	29.5	32.3	34.2	36.0	40.3
-OP. COST	202.2	222.9	244.3	264.9	286.3	313.7	286.9	344.2
-INTEREST	18.6	15.1	11.5	8.0	4.4	0.0	0.0	0.0
-DEPRECI.	26.7	26.4	27.8	29.6	33.4	33.9	37.9	30.8
-ALLOWANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-CARRY LOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TAXABLE IN	89.0	93.0	105.7	127.2	147.4	152.1	203.6	219.3
-TAX@46.0%	40.9	42.8	48.6	58.5	67.8	70.0	93.7	100.9
NET INCOME	48.0	50.2	57.1	68.7	79.6	82.1	109.9	118.4
+DEPRECI.	26.7	26.4	27.8	29.6	33.4	33.9	37.9	30.8
+ALLOWANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+CARRY LOS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+BORROWING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-REPAYMENT	29.6	29.6	29.6	29.6	37.0	0.0	0.0	0.0
-CAP.EXP.	14.8	15.5	23.0	26.6	37.0	28.9	40.0	2.3
-WORK.CAP.	2.8	4.0	4.5	4.1	4.2	5.6	0.0	14.4
N.C.F.	27.6	27.6	27.8	38.0	34.8	81.5	107.8	132.5
DEBT COVERAGE RATIO	1.57	1.52	1.68	2.01	1.84	0.00	0.00	0.00

FIGURE 7

ROR/NPV Profile



net annual cash flow are quite different. Obviously, the net annual cash flow for the leveraged case is smaller than that for the all-cash case during a loan period (from 1983 to 1995). The difference between the all-cash case and the leveraged case is due to deduction for interest, borrowed money, and repayment of loan. Interest is deducted for tax purposes. For instance, if the tax rate is 46 percent and interest is paid per year, the negative cash flow for interest becomes $54 ($100 x (1 - 0.46)). The relationship between the borrowed money and the repayment of the loan plays a role in the reallocation of investments.

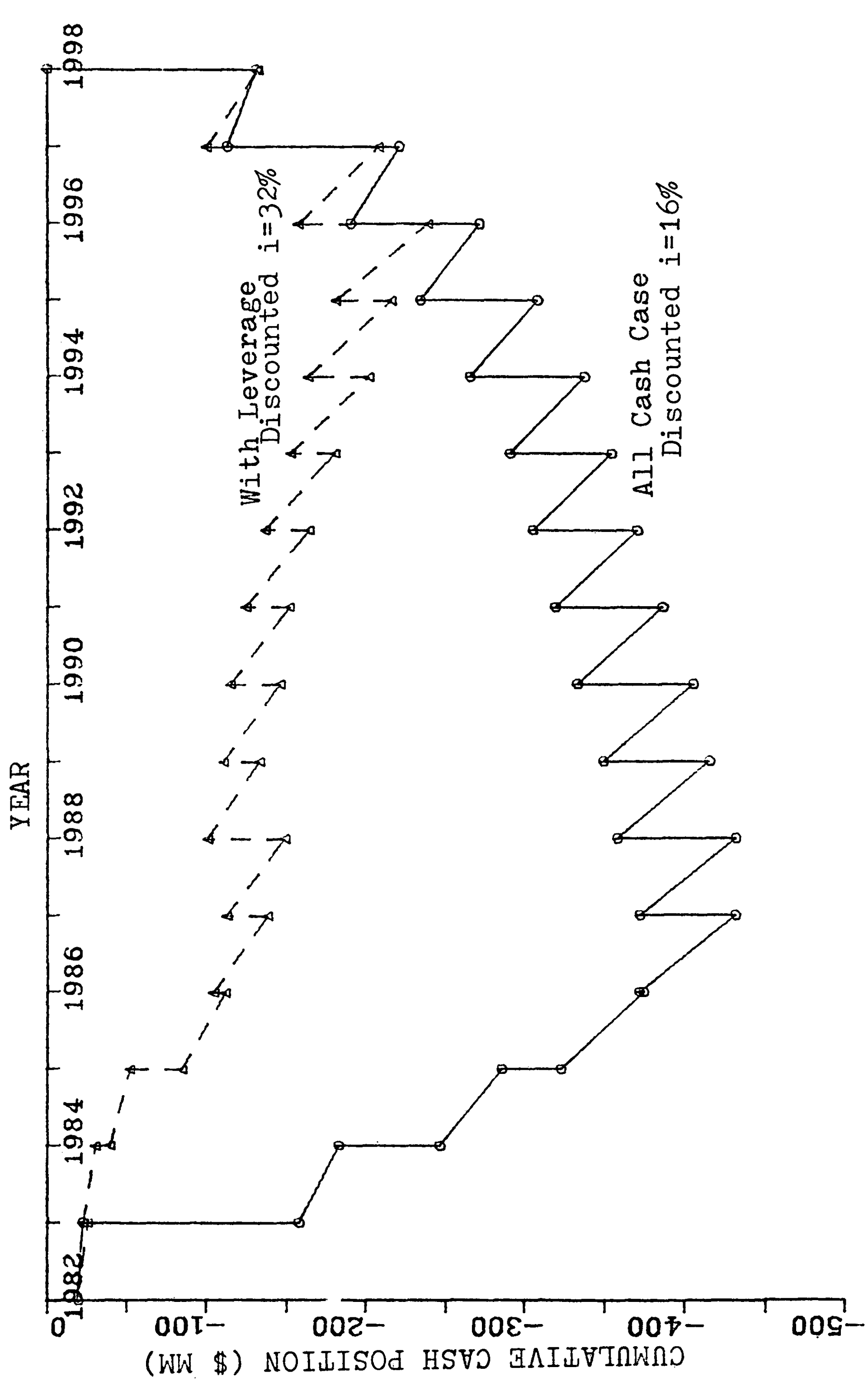
The borrowing of money generally will occur at the beginning of a project. This means that such cash outlays as capital expenditures will be shifted backwards in the form of repayment of the loan. Since the evaluation technique mentioned here is based on discounting cash flow, the beginning of annual cash flow affects the evaluation result. In using borrowed money a project becomes better so long as the after-tax cost of borrowed money is less than the cash investment DCFROR (Stermole, 1980, p.317). In this project, the after-tax cost of borrowed money is 6.48 percent (12 percent x (1 - 0.46)) and the cash investment DCFROR is 16.0 percent. So if an interest rate is more than 29.6 percent (16.0 x 1/(1 - 0.46)), the leveraged case becomes worse than the all-cash case (considering interest as the only cost of borrowed money).

The leveraged DCFROR is twice the cash investment ROR. A cumulative cash position diagram can explain this (Figure 8). "Cumulative cash position is the investment principal and accrued interest that has not been amortized by revenue such as profits, salvage value, savings, mortgage payments, or other inflows of money." (Stermole, 1980, p.42) The diagram shows that the DCFROR for both cases make the cumulative cash positions zero at the end of the evaluation life. Since the unamortized equity investment principal in the leveraged case is much smaller than that in the all-cash case, the DCFROR, which is based on the unamortized investments, for both cases are completely different (Stermole, 1980, pp.317-318). Figure 8 indicates clearly that the negative cummulative cash positions of the first years in the leveraged case are much smaller than those in the all cash case. This makes DCFROR for the leveraged case better than that for the all-cash case because of the concept of the time value of money.

The payback period in the leveraged case is shorter than that in all-cash case. The meaning of payback period in each case is quite different. Because the company still has an obligation to repay the loan after the payback period in the leveraged case, it is not rational to compare the payback

FIGURE 8

Cumulative Cash Position Diagram



periods. This does not affect the payback-period criteria; the method still plays the role of a risk indicator.

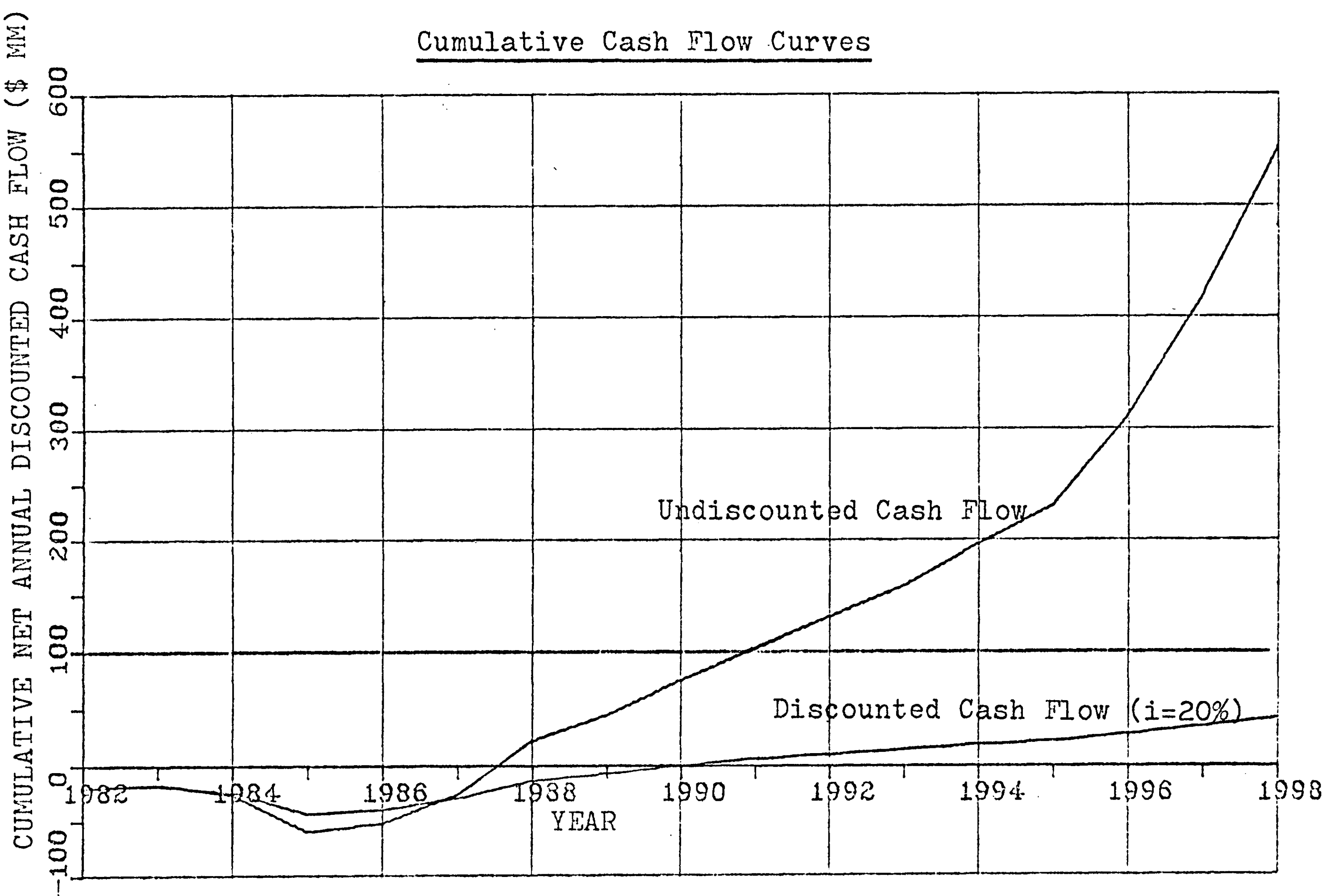
As to a variation of payback-period criterion, a discounted payback period criterion can be considered. This method can overcome one of the disadvantages of the ordinary payback period method, which is neglect of the time value of money, while still neglecting the cash flows beyond a payback period. In this project, the discounted payback period in the leveraged case at the 20 percent minimum ROR is 5.90 years.

Figure 9 shows the cumulative cash flow curves. In evaluating an investment proposal, it is useful to consider the whole of the cumulative discounted cash flow curve from the beginning to the end of an evaluation life. This curve gives us some useful information about the investment. First, the period during which capital is at risk (negative values) is measured from the start of the project to the final point at which the cumulative discounted cash flow (CDCF) curve intersects the X-axis (Year) from a negative value to a positive value of CDCF. This concept is similar to discounted payback period, but, is measured from the start of production. It is true that some people consider the discounted payback period to be measured from the start of the project.

Second, consider the overall shape of the curve. Sinclair suggests using the ratio of the area between the

FIGURE 9

Cumulative Cash Flow Curves



positive CDCF curve and the X-axis to the area between the negative CDCF curve and the X-axis (Sinclair, 1966, p.137). Obviously the higher the ratio, the more attractive a project is from a viewpoint of profitability.

5-3 Sensitivity Analysis

In the previous section the evaluation was based only on the base case which is predicted by the operating company JOVE. Whether this base case is conservative or not, it is very important for the bank to make a sensitivity analysis because a bank is normally a risk averter. Actually it is very rare that the prediction of the base case comes true since there is large uncertainty in the future. Sensitivity analysis measures the relationship between an input (errors in the cash flow prediction) and overall profitability. This analysis is commonly criticized in that it makes only one parameter change at a time. Another aim of this analysis is to determine which parameter of a project is most critical for profitability. When the bank knows this critical parameter, they can investigate it thoroughly. In this section, several parameters are considered: revenue (price), production, operating cost, capital expenditure, tax rate, interest rate, period of repayment, and debt amount. The sensitivities of the project are evaluated between +20 percent and -20 percent variations in the parameters (some parameters are considered at ±30 percent variations). Both the all-cash case and the leveraged case are considered, where possible, in order to stress the effect of debt financing. DCFROR and NPV are measured as profitability indices.

First, revenue (price) is considered. This particular project decreases the market risk through a long-term sales contract, but the buyers and the sellers must negotiate a base price every two years. Since oil prices are fluctuating, it is necessary to evaluate price variations. Table 13 shows some parts of the results in the leveraged case. The bank should look not only for a profitability index but also for the coverage of debt repayment which is discussed in the next section. Even if the percentage change is -10 percent, the new ROR is less than 20 percent of minimum ROR. When the percentage change is -20 percent, the new ROR is almost zero. As a result, it is easily understood that price is a very critical factor in the profitability of the project.

Secondly, the production rate is considered. About two million tons (70 percent of full production) will be shipped to Japan under the long-term sales contract. Other portions of the production are meant to be sold in the spot market. Therefore, the sensitivity analysis for the production rate is evaluated from a -30 percent change.

Thirdly, operating cost and capital expenditure are made separately. As mentioned in chapter 3, these overrun

TABLE 13

Summary of Cash Flow - Sensitivity Analysis

Revenue(price) Case

Net Annual Cash Flow unit: $M

Year	-20%change	-10%change	base case	+10%change	+20%change
1982	-19.7	-19.7	-19.7	-19.7	-19.7
1983	2.8	2.8	2.8	2.8	2.8
1984	-12.8	-11.1	-9.3	-7.5	-5.8
1985	-53.1	-42.9	-32.5	-22.2	-11.9
1986	-27.7	-10.1	7.4	24.9	42.5
1987	-18.1	3.7	25.4	43.4	41.5
1988	6.6	35.7	48.2	44.0	59.7
1989	-11.4	17.4	22.5	38.1	53.7
1990	2.2	24.2	30.9	47.7	64.6
1991	1.2	9.4	27.6	45.8	63.9
1992	-1.0	8.3	27.6	46.8	66.1
1993	-1.4	6.8	27.8	48.8	69.8
1994	10.6	14.9	38.0	61.3	84.4
1995	-12.5	9.3	34.8	60.3	85.7
1996	27.5	54.5	81.5	108.5	135.5
1997	50.8	79.3	107.8	136.4	164.9
1998	68.4	100.4	132.5	164.7	196.7
NPV(@20%)	-69.1	-9.4	42.3	92.2	140.7
DCFROR	0.8%	17.3%	32.0%	45.1%	56.5%

costs lead frequently to project failure.

It is very useful to make tables or plot curves that show the effect on profitability of changes in parameters. The summary of such changes in the all-cash case is presented in Table 14 and Figure 10. That in the leveraged case is also shown in Table 15 and Figure 11. The main concern for the bank is in the effect of a negative percentage change in the prediction of ROR. It is obvious that the most sensitive parameter is price and the second is operating cost. Comparing the all-cash case with the leveraged case, it is clear that debt financing makes the project profitable, but the profitability of the project fluctuates more than in the all-cash case whenever the predicted parameters change. Consequently the project in the leveraged case will be in danger when the parameter changes for the worst.

Next, tax rate is considered. The tax rates levied on the mining business are different for different countries. A tax rate is sometimes changed by Government for political or economical reasons. For instance, in the United States, state severance taxes on coal are different state-by-state. Table 16 shows the summary of results. Every rule has an exception. Concerning taxation, the ROR of the all-cash case is more sensitive to change of the tax rate than that of the leveraged case because of the effect of reduced tax

TABLE 14

Sensitivity Analysis -- All Cash Case

% variable change	Revenue(Price) ROR (% change)	Production ROR (% change)	Operating Cost ROR (% change)	Capital Expenditure ROR (% change)
	% %	% %	% %	% %
-20 %	4.6 (-71.3)	12.2 (-23.8)	21.2 (32.5)	19.6 (22.5)
-15 %	8.1 (-49.4)	13.2 (-17.5)	20.0 (25.0)	18.6 (16.3)
-10 %	11.0 (-31.3)	14.2 (-11.3)	18.7 (16.9)	17.7 (10.6)
- 5 %	13.7 (-14.4)	15.1 (- 5.6)	17.4 (8.8)	16.8 (5.0)
Base Case 0 %	16.0 (0)	16.0 (0)	16.0 (0)	16.0 (0)
5 %	18.2 (13.8)	16.8 (5.0)	14.6 (- 8.8)	15.3 (- 4.4)
10 %	20.2 (26.3)	17.6 (10.0)	13.1 (-18.1)	14.6 (- 8.8)
15 %	22.1 (38.1)	18.4 (15.0)	11.5 (-28.1)	13.9 (-13.1)
20 %	23.9 (49.4)	19.2 (20.0)	9.7 (-39.4)	13.3 (-16.9)

FIGURE 10

Sensitivity Analysis -- All Cash Case

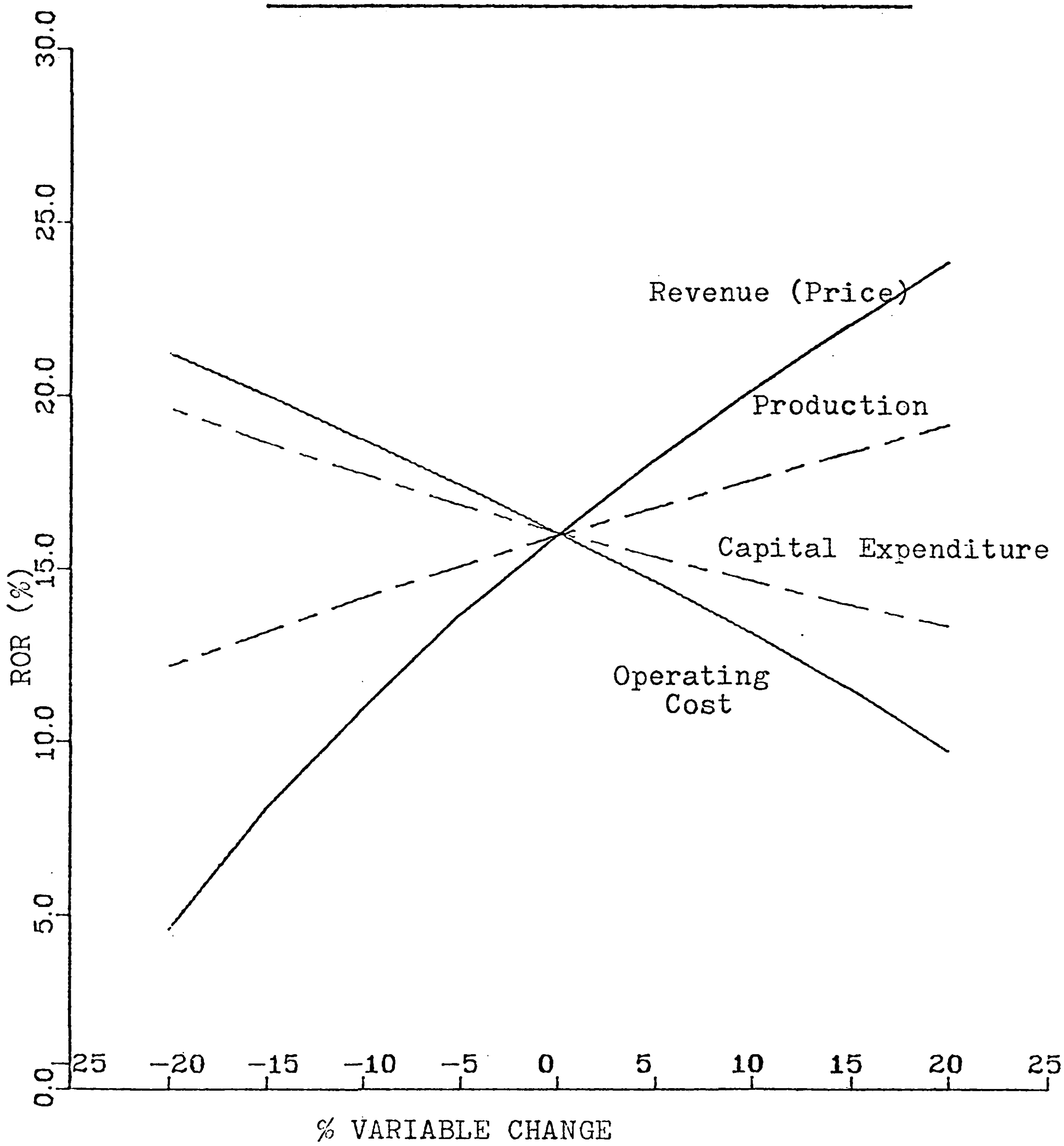


TABLE 15

Sensitivity Analysis - With Leverage

% variable change	Revenue(Price) ROR	(% change)	Production ROR	(% change)	Operating Cost ROR	(% change)	Capital Expenditure ROR	(% change)
	%	%	%	%	%	%	%	%
-30 %			15.1	(-52.8)	57.5	(79.7)		
-20 %	0.8	(-97.5)	21.3	(-33.4)	49.6	(55.0)	97.0	(203.1)
-15 %	9.1	(-71.6)	24.2	(-24.4)	45.6	(42.5)	63.6	(98.8)
-10 %	17.3	(-45.9)	26.9	(-15.9)	41.3	(29.1)	46.9	(46.6)
- 5 %	25.0	(-21.9)	29.5	(- 7.8)	36.9	(15.3)	37.9	(18.4)
Base Case 0 %	32.0	(0)	32.0	(0)	32.0	(0)	32.0	(0)
5 %	38.7	(20.9)	34.4	(7.5)	27.9	(-12.8)	27.8	(-13.1)
10 %	45.1	(40.9)	36.8	(15.0)	23.4	(-26.9)	24.7	(-22.8)
15 %	50.9	(59.1)	39.0	(21.9)	18.5	(-42.2)	22.1	(-30.9)
20 %	56.5	(76.6)	41.2	(28.8)	13.7	(-57.2)	20.1	(-37.2)
30 %	(66.9)	(109.1)	(45.4)	(41.9)	3.8	(-88.1)	16.8	(-47.5)

FIGURE 11

Sensitivity Analysis -- With Leverage

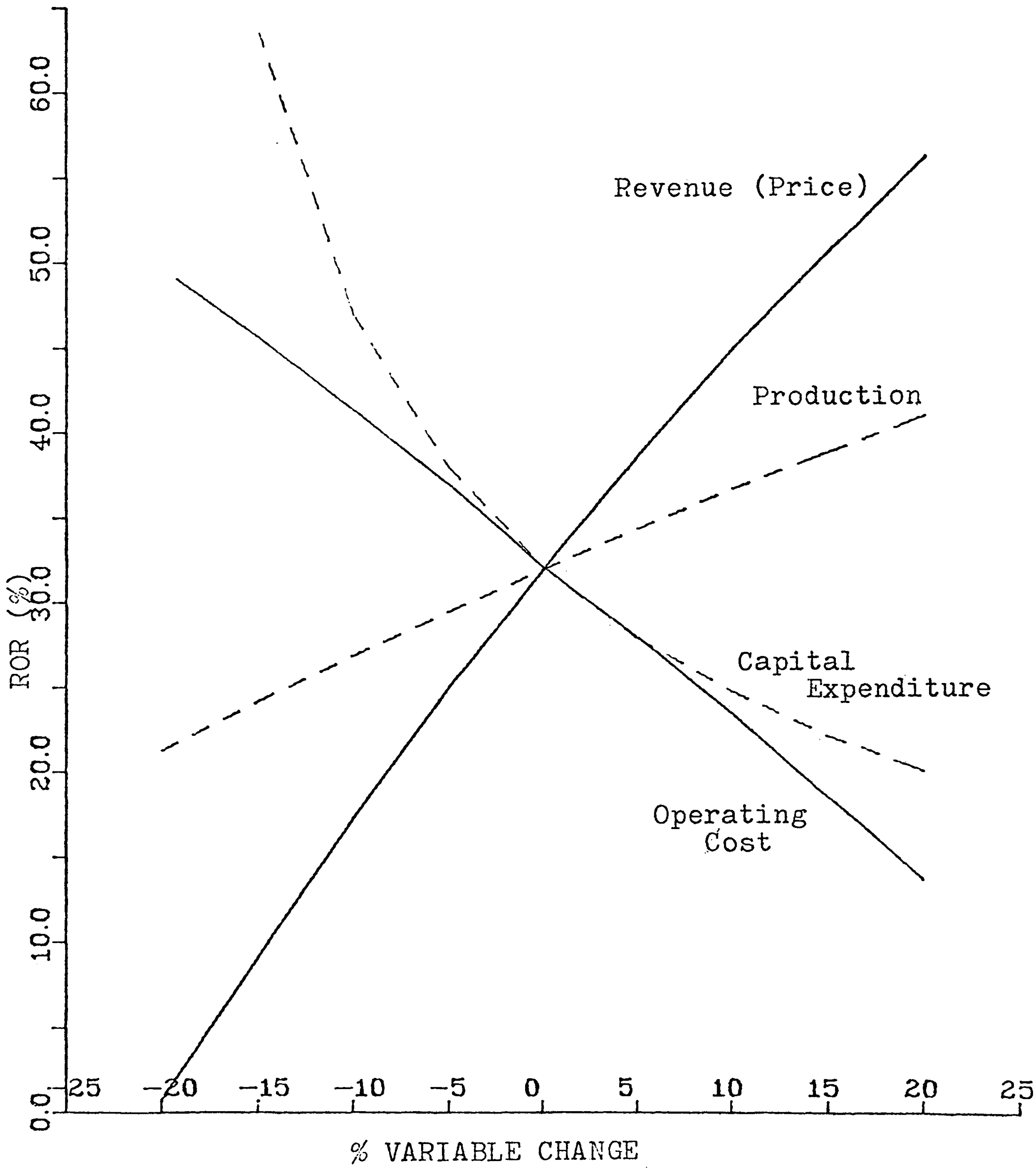


TABLE 16

Sensitivity Analysis -- Taxation

	Tax Rate (% change)	All Cash Case ROR (% change)	With Leverage ROR (% change)
	40 % (-13.0%)	17.3% (8.1%)	33.7% (5.3%)
	42 % (- 8.7)	16.9 (5.6)	33.1 (3.4)
	44 % (- 4.3)	16.5 (3.1)	32.6 (1.9)
Base Case	46 % (0)	16.0 (0)	32.0 (0)
	48 % (4.3)	15.6 (- 2.5)	31.4 (- 1.9)
	50 % (8.7)	15.1 (- 5.6)	30.7 (- 4.1)
	55 % (19.6)	13.9 (-13.1)	29.0 (- 9.4)
	60 % (30.4)	12.6 (-21.3)	27.0 (-15.6)
	65 % (41.3)	11.2 (-30.0)	24.8 (-22.5)

on interest. Even if the tax rate goes up to 65 percent, the new ROR still remains 24.8 percent. Therefore, the tax rate is not a critical factor for this project.

The interest rate is considered next. The most simple factor determining the interest rate is that it is a function of the demand for, and the supply of, money. Practically, several other factors affect the level of the interest rate in a complicated way. In the real world, a floating interest rate is often applied. The results are presented in Table 17. The new ROR varies inversely with changes in interest rates. A decrease in the interest rate increases the new ROR by a percent larger than an equal increase in the interest rate would decrease the new ROR. Compared with the tax rate, the interest rate is more critical to the project. If the interest rate goes up to 22 percent, the new ROR becomes 18.9 percent, which is less than the 20 percent minimum ROR.

Finally, debt amount and period of repayment are considered separately. For comparison purposes, it is assumed that the loan principal is repayed in equal amount at the end of each year. The debt amount is considered from -20 percent debt to +20 percent debt each year; the period of repayment is considered from 5 years to 12 years. That of the base case is 9 years.

TABLE 17

Sensitivity Analysis -- Interest

	Interest Rate	(% change)	ROR	(% change)
		%	%	%
	8 %	(-33.3)	39.3	(22.8)
	10 %	(-16.7)	35.4	(10.6)
Base Case	12 %	(0)	32.0	(0)
	14 %	(16.7)	28.9	(- 9.7)
	16 %	(33.3)	26.0	(-18.8)
	18 %	(50.0)	23.4	(-26.9)
	20 %	(66.7)	21.0	(-34.4)
	22 %	(83.3)	18.9	(-40.9)

Figure 12 illustrates the results. The variations in the new ROR in each case are as follows: base case, from 26.7 percent to 34.3 percent; +20 percent debt case, from 39.6 percent to 64.9 percent; +10 percent debt case, from 30.8 percent to 43.4 percent; -10 percent debt case, from 24.2 percent to 29.2 percent; and -20 percent debt case, from 22.4 percent to 25.9 percent. From the viewpoint of profitability, the new ROR's of all the cases are above the 20 percent minimum ROR, so all cases seem to be satisfactory. This is not true, as described in the next section.

According to Figure 12, it can be easily seen that the longer the period of repayment, the higher the profitability for any given debt amount, and that the more the debt amount, the higher the profitability for any given period of repayment. It can also be seen that the greater the debt amount, the larger the change of profitability from period to period.

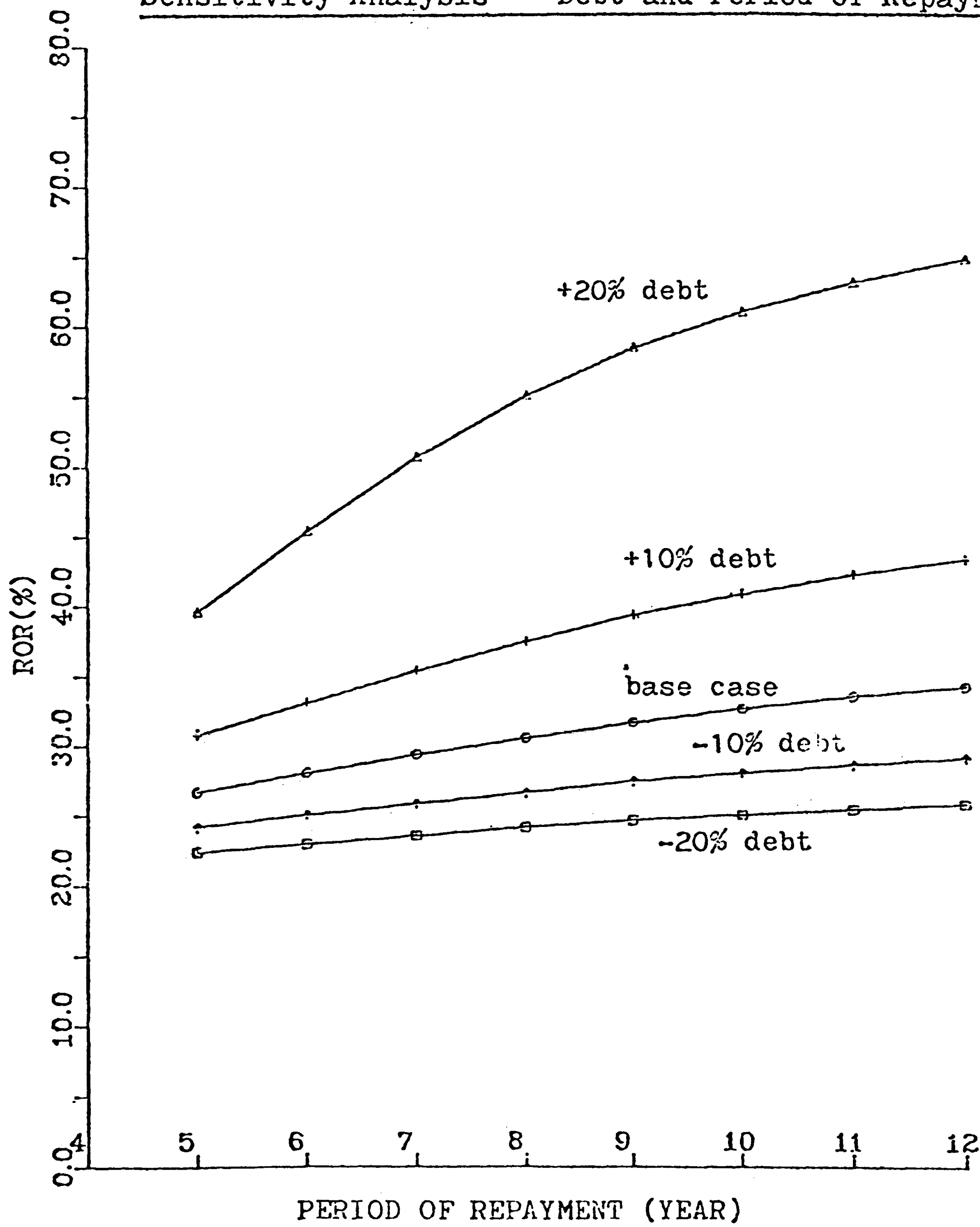
5-4 Cash Flow Debt Coverage Ratio

In the preceeding sections, the profitability of the project was the main concern. The bank's main concern, however, is the repayment of the loan. It is the cash flow debt coverage ratio (CCR) that can measure this. The CCR is calculated each year and is expressed in equation form as follows:

$$\mathrm{CCR} = \frac{\text{(Net Income)} + \text{(Total Non-cash Charges)} + \text{(Interest)} - \text{(Capital Expenditure)} - \text{(Working Capital)}}{\text{(Interest)} + \text{(Repayment of Principal)}}$$

FIGURE 12

Sensitivity Analysis -- Debt and Period of Repayment



Total noncash charges include depreciation, allowance, and carry loss forward. The CCR can make clear the projected cash flow stream in relation to the anticipated debt servicing requirements. CCR makes sense to the banker only when the projected cash flow is reasonably accurate.

Bank conservatism requires a CCR above at least 1.0 each year. A banker expects the CCR to be 1.2 annually for a project, but treats the CCR differently for each project dependent upon such factors as credit-worthiness of the sponsors, sales contract, degree of leverage, and so forth (Ulatowski, 1980, p.688). In this thesis, when the CCR is less than 1.0, we call it violated, and when the CCR is between 1.0 and 1.2, we call it not preferable.

This author describes the relationship between the CCR and several of the cases which were analysed in the sensitivity analysis section. First, revenue (price) is considered. Changes of -10 percent, -15 percent, and -20 percent in revenue (price) are made. The resulting CCR's are plotted in Figure 13. The dots under the X-axis indicates that the predicted cash flow violates the schedule of repayment of the loan. The dots between the dashed line and the X-axis indicates that the predicted cash flow is not preferable from the viewpoint of bank conservatism, but may be accepted by the bank depending on conditions. Both -20 percent and -15 percent change cases violate the schedule of the repayment. The -10 percent

FIGURE 13

Cash Flow Debt Coverage Ratio - Revenue(price)

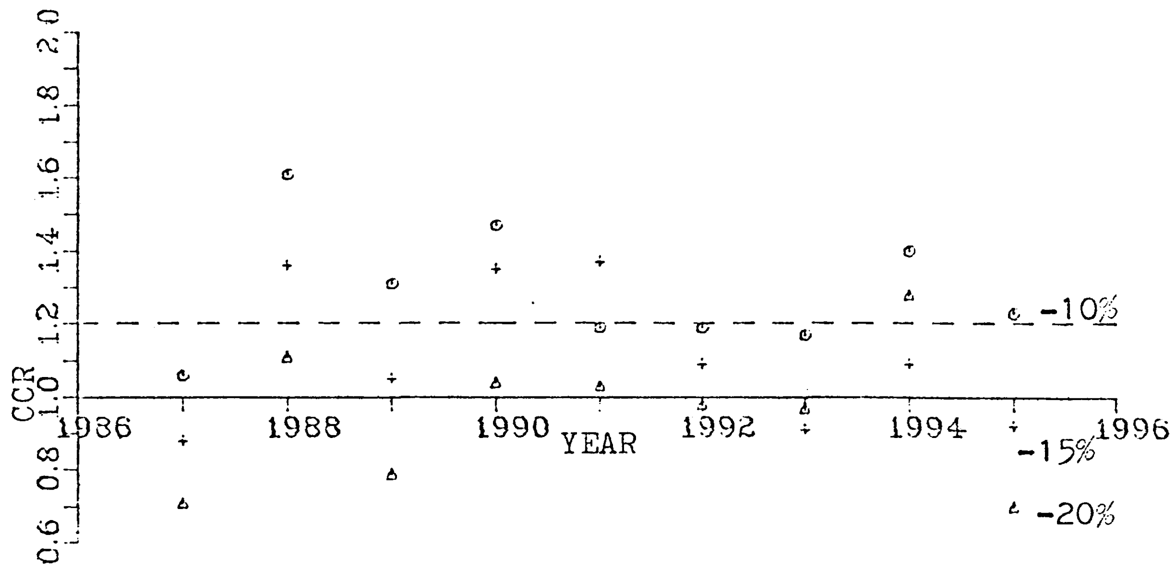
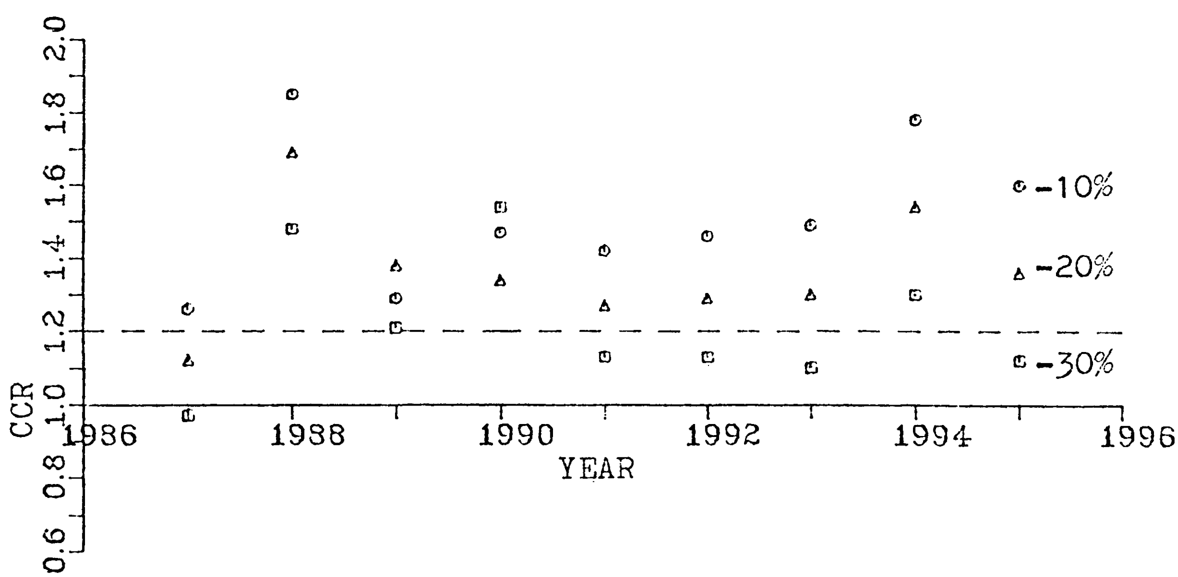


FIGURE 14

Cash Flow Debt Coverage Ratio - Production



change case is not a preferable situation. Their ROR's are 0.8%, 9.1%, and 17.3% respectively. From both points of view, which are concerned with profitability and loan repayment, these cases are dangerous ones.

Secondly, production is considered. The -10 percent, -20 percent, and -30 percent change cases are evaluated and presented in Figure 14, and the following CCR calculations are made for the same set of percentage change cases. In the case of -30 percent change, the predicted cash flow violates the repayment of the schedule in 1987 and the other four years present unpreferable situations; the ROR is 15.1 percent, which is less than the 20 percent minimum ROR. In the case of -20 percent change, the year 1987 is unpreferable, but the other years' CCR are above 1.2. The ROR is 21.3 percent, so the unpreferable situation may be accepted by the bank.

Thirdly, operating cost is considered and presented in Figure 15. In the case of +20 percent change, four years of the repayment life are unpreferable situations. The ROR is 13.7%, so this case is not desirable to the bank.

Fourthly, capital expenditure is considered. All the CCR's in these three cases are satisfactory to the bank (Figure 16), but the ROR of the +30 percent change case is 16.8%, which is undesirable for the bank despite the results of the CCR.

FIGURE 15

Cash Flow Debt Coverage Ratio - Operating Cost

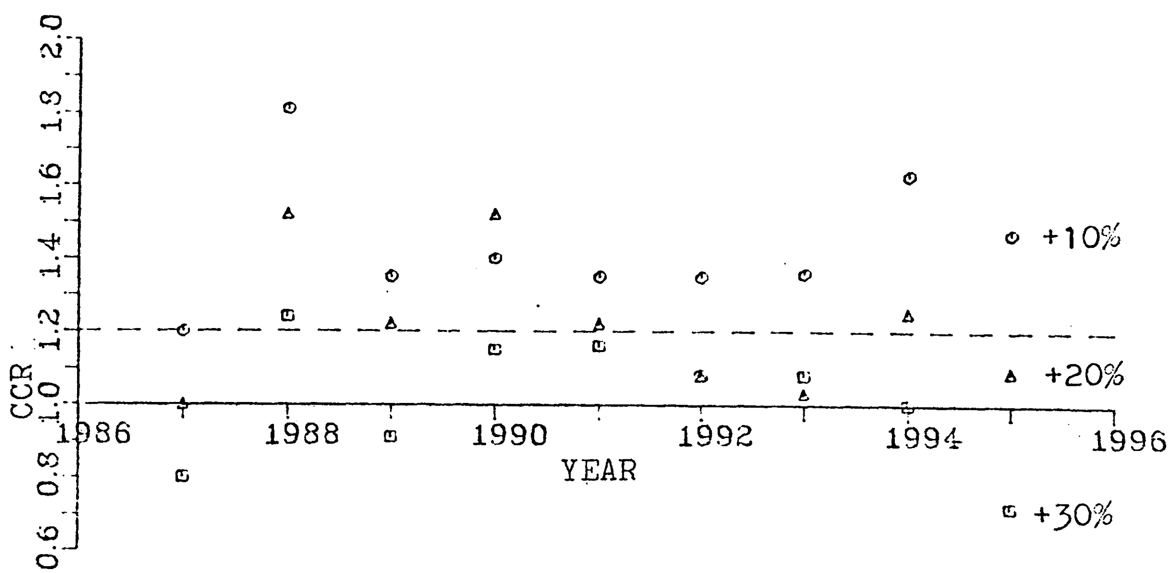
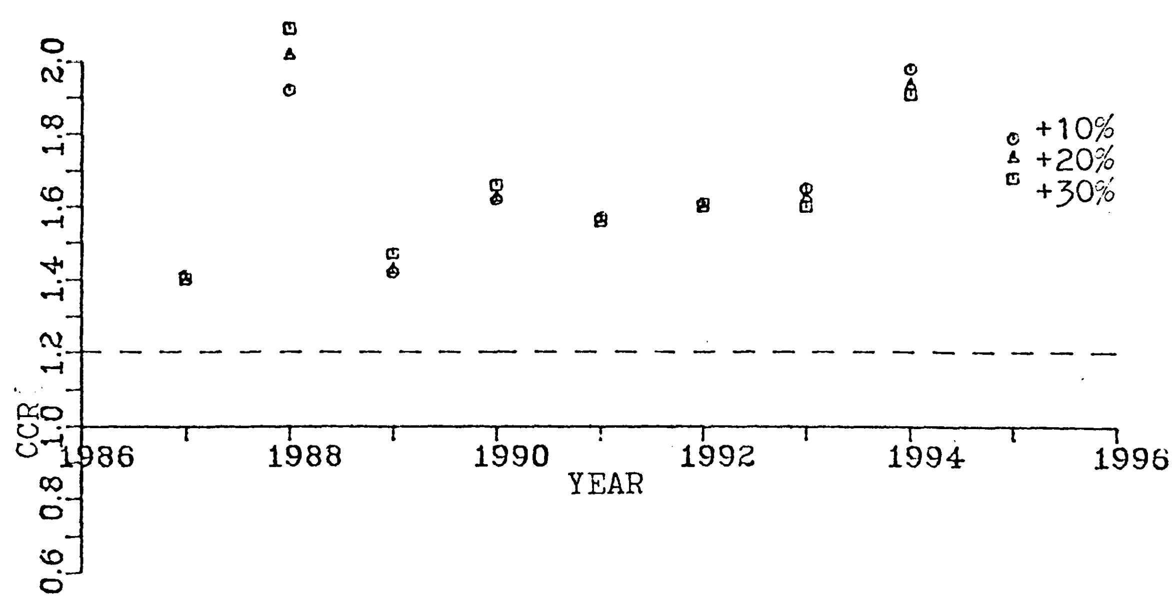


FIGURE 16

Cash Flow Debt Coverage Ratio - Capital Expenditure



The relationship among the debt amount, the period of repayment, and the CCR is discussed next. Table 18 shows the comparison of the CCR with the different periods of the repayment cases for a given debt amount. The longer the period of repayment, the bigger the CCR at each year and the larger the profitability. No cases violate the schedule of repayment, and all the CCR for the cases whose periods of the repayment are more than seven years are above 1.2. There is some room to shorten the period of repayment when the repayment period is nine years.

Tables 19, 20, and 21 show the comparison of the CCR for the different debt amounts for a given period of repayment. When the period of repayment is five years, the increases debt cause violation of the schedule of repayment despite the new fact that the ROR is above the 20 percent minimum. When the period of repayment is seven years, the increases in debt make the CCR unpreferable situations (Table 20). When the period of repayment is nine years (base case), only year 1987 and 1989 are unpreferable situations for the 20 percent increase debt case (Table 21).

Considering these comparisons, the more the debt increases for a given period of repayment, the worse the CCR. Especially the CCR's of year 1987 and 1989 are relatively low. It is very important to use the CCR not only to check violation of

TABLE 18

Comparison of CCR - Period of Repayment

Year	Period of Repayment 5yrs	6yrs	7yrs	8yrs	9yrs	10yrs	11yrs	12yrs
1987	1.00	1.12	1.22	1.31	1.39	1.46	1.52	1.58
1988	1.31	1.46	1.58	1.70	1.80	1.88	1.96	2.03
1989	1.01	1.13	1.23	1.31	1.39	1.46	1.51	1.57
1990	1.16	1.29	1.40	1.50	1.58	1.65	1.71	1.77
1991	1.15	1.28	1.39	1.48	1.55	1.62	1.68	1.73
1992		1.33	1.44	1.53	1.60	1.66	1.72	1.77
1993			1.50	1.59	1.66	1.72	1.77	1.81
1994				1.93	2.00	2.05	2.10	2.14
1995					2.23	2.28	2.32	2.35
1996						2.71	2.73	2.75
1997							3.92	3.90
ROR	26.7%	28.1%	29.4%	30.6%	31.7%	32.7%	33.6%	34.3%

TABLE 19

Cash Flow Debt Coverage Ratio

5 years Repayment

Year	Debt Amount -20% change	-10% change	-5% change	+5% change	+10% change	+20% change
1987	1.25	1.11	1.06	0.96	0.91	0.84
1988	1.45	1.37	1.34	1.28	1.25	1.21
1989	1.23	1.11	1.06	0.96	0.91	0.84
1990	1.42	1.28	1.21	1.11	1.06	0.98
1991	1.42	1.27	1.20	1.09	1.05	0.96
ROR	22.4%	24.2%	25.3%	28.4%	30.8%	39.6%

TABLE 20

Cash Flow Debt Coverage Ratio

7 years Repayment

Year	Debt Amount -20% change	-10% change	-5% change	+5% change	+10% change	+20% change
1987	1.53	1.36	1.29	1.16	1.11	1.02
1988	1.76	1.66	1.62	1.55	1.52	1.47
1989	1.49	1.35	1.28	1.18	1.13	1.05
1990	1.71	1.54	1.47	1.34	1.29	1.19
1991	1.70	1.53	1.45	1.33	1.27	1.18
1992	1.77	1.59	1.51	1.37	1.31	1.21
1993	1.86	1.66	1.58	1.43	1.37	1.26
ROR	23.6%	25.9%	27.5%	31.9%	35.4%	50.7%

TABLE 21

Cash Flow Debt Coverage Ratio

9 years Repayment

Year	Debt Amount -20% change	-10% change	-5% change	+5% change	+10% change	+20% change
1987	1.74	1.54	1.46	1.32	1.26	1.16
1988	1.99	1.88	1.84	1.76	1.73	1.67
1989	1.68	1.52	1.45	1.33	1.28	1.19
1990	1.92	1.73	1.65	1.51	1.45	1.35
1991	1.90	1.71	1.63	1.49	1.43	1.32
1992	1.96	1.76	1.68	1.53	1.47	1.36
1993	2.04	1.83	1.74	1.59	1.52	1.40
1994	2.47	2.21	2.10	1.91	1.82	1.68
1995	2.77	2.47	2.34	2.12	2.03	1.87
ROR	24.7%	27.5%	29.3%	34.9%	39.4%	58.5%

the repayment schedule but also to describe the features of the predicted cash flow.

6. OTHER CONSIDERATIONS

6-1 Bankers' Decision Criteria

In the previous chapter, the project was evaluated from the viewpoint of not only profitability, but also repayment of the loan. No one criterion by itself will be used to decide whether money should be loaned to a project. It is suggested that several decision criteria be used to make this judgement, using the bankers' common sense and knowledge. These considerations are abstract, including market analysis, country risk considerations, and so forth, and should be customarily used in all cases.

There are two paths for decision criteria, an accept/reject criterion and a ranking criterion. The NPV method naturally used both criteria. The DCFROR method can also handle both criteria, with some modification. For a bank, the author thinks, the accept/reject criterion is more important than the ranking criterion because each project comes to the bank individually, and the bank has to evaluate projects one by one.

It is very important for the bank to compare projects. The bank often compares the borrower's financial ratios with those of other companies', especially those in the same industry, for the case of ordinary term loans. It is useful to compare a particular project with other similar projects.

The bank may then get distinctive features of the project through the comparison.

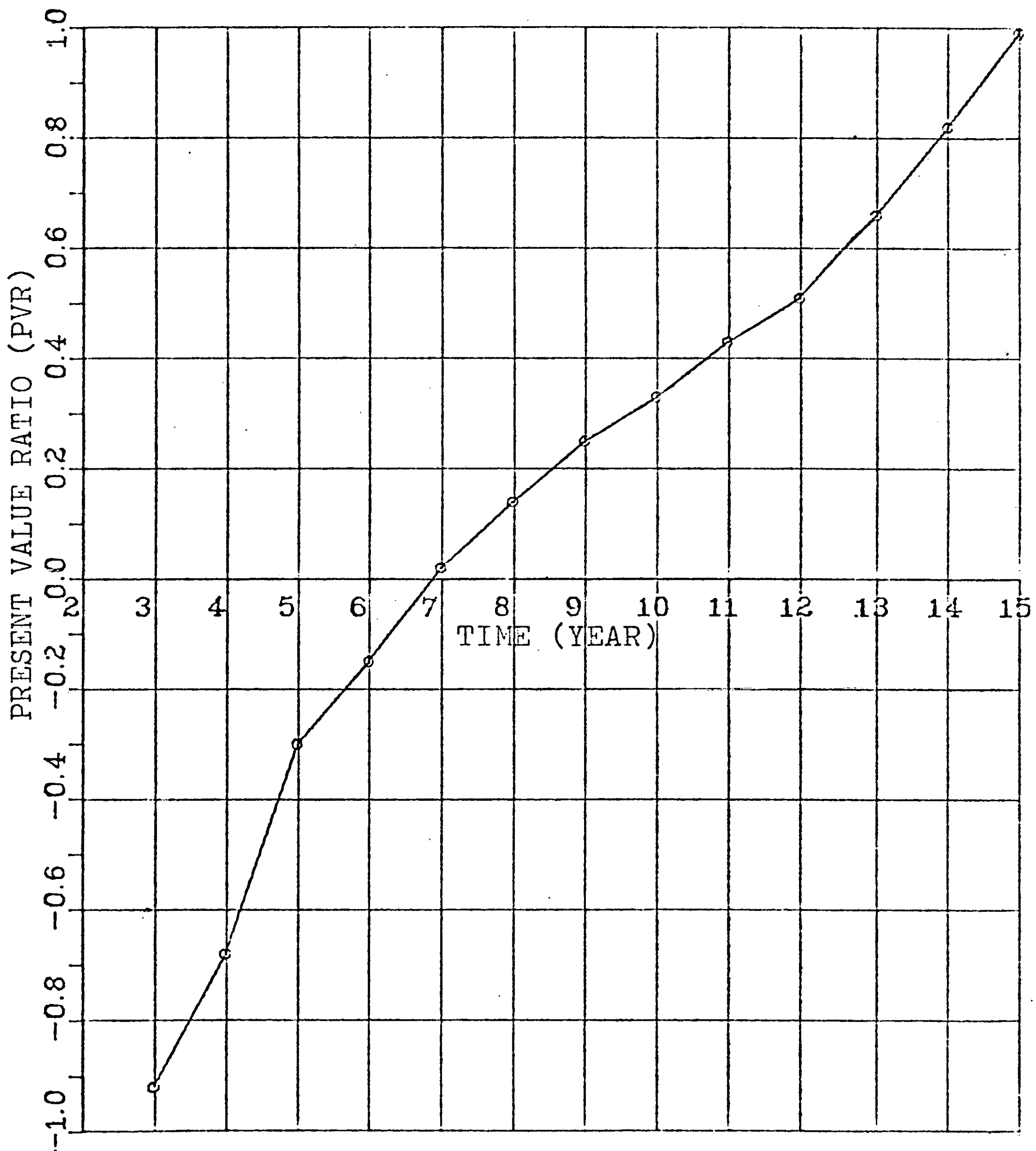
For instance, consider the present value ratio (PVR). PVR is defined as the ratio of the net present value to the present worth investment cost at the minimum ROR (Stermole, 1980, p.118). For the bank, new projects are generally not mutually exclusive. Selection of projects based on decreasing order of PVR maximizes the cumulative NPV of projects.

Today, however, it is uncommon for Japanese banks to have several proposals for project financing at the same time. Only then does a criterion such as PVR have meaning for comparison purposes. Figure 17 shows the calculated PVR against time over the evaluation life of the base case coal project for the 20 percent minimum ROR. This curve indicates not only an overall profitability trend, but also the simplicity of comparing the PVR of projects over time.

Japanese commercial banks are just now at the first stage of project financing so they do not have enough of the knowledge and data needed to evaluate projects. They should therefore store project data and analyse past projects and then establish their own cut-off points for several criteria. For example, they should determine cut-off periods, which probably vary with country, kind of minerals, and so on, in the payback-period criteria. This means that if the payback period of a certain project is longer than the cut-off payback

FIGURE 17

Present Value Ratio - Time Series



period, that project would be rejected.

Finally, a bank should not forget the riskiness of project financing. This riskiness permits the addition of a risk premium to the minimum ROR when calculating NPV. From a banker's perspective, if there are doubts about a project, whether it is small or not, the bank should not lend money to it.

6-2 Inflation

There was a small worldwide inflation in the 1950's and 1960's, but in recent years the worldwide inflation rate has increased, and it must always be considered when evaluating projects today.

By definition, "inflation is a persistent rise in the general price level, as measured by indices such as the Consumer Price Index, the Wholesale Price Index, or the GNP Deflator." (Davidson, 1975, p.1184) Escalation is the increase in the cost or price of a limited group of related goods or services. This increase is caused by a combination of factors, such as that presence of inflation, supply and demand, scarcity of particular product, and et cetera (Dayton, 1978, p.4).

When evaluating a project, we must determine escalation rates on such items as price, operating cost, and other relevant factors. It is very difficult to estimate these rates, but several indices, such as those of the U.S. Bureau of Labor Statistics, the Marshall and Swift equipment cost indices, and others, are helpful in predicting future costs and prices with some reliability.

There are two methods to take inflation into account properly when evaluating projects. One is current-dollar analysis; the other is constant-dollar analysis. In current-dollar analysis, it is necessary to estimate the dollar value of revenues or costs in the year incurred at their actual value. On the other hand, the constant dollar analysis evaluates a project using the constant purchasing power of the dollar value at a special point in time, usually at the starting point of the evaluation life. The results of both analyses on the same project are the same if these analyses are conducted properly (Dayton, 1978, p.65).

For instance, when we evaluate the project with leverage using constant dollar value, we should not forget that inflation decreases the real values of principal repayment, interest, and depreciation. We should therefore discount these values at the inflation rate. It is true that any increase in inflation lessens the burden of paying interest and principal. I have used the current-dollar analysis in this thesis.

The increase in inflation affects the minimum ROR. In current-dollar analysis, a discount rate is determined as follows: (Stermole, 1980, p.170)

$$1 + i = (1 + f)\ (1 + i')$$

where i is the current dollar ROR

i' is the constant dollar ROR

f is the inflation rate.

As a result, the higher the inflation rate, the higher the current-dollar ROR. The presence of inflation makes the minimum ROR, used to determine present value, increase. The values of future cash flow are weakened by the effects of inflation. Thus the increase in inflation may require an earlier payback period.

6-3 Exchange Rate

There is a floating exchange rate system in the foreign exchange market today. An exchange rate is determined by several factors, such as interest rate, foreign exchange holdings, speculation, and so on. It is quite difficult to predict future exchange rates, but any considerable change predicted should be taken into account when evaluating international projects.

For instance, assume that a certain project is in Canada. Canadian dollars are used in the operation, including revenue, but money is borrowed in terms of U.S. dollars from American banks. If a devaluation of U.S. dollars occurs, the payments of interest and principal will be less than expected so projected net annual cash flow will increase. On the contrary, if a revaluation of U.S. dollars occurs, payments of interest and principal will be greater than expected, so projected net annual cash flow will decrease; this could lead to bankruptcy.

To avoid the risk of changes in the foreign exchange rate, the currency of borrowed money should be the same as that of the main revenues. Another possible solution would be to split the loan 50/50 between U.S. and Canadian dollars. This means that it is important for the bank to examine how a project will hedge these risks in the evaluation of international investment projects. It goes without saying that if the exchange rate changes drastically, the economic evaluation has to be revised.

7. CONCLUSION

Coal is expected to be used as an alternative energy source for oil in the world. In particular, Japan is promoting the use of coal. Considerable capital costs are usually required in the development of new coal mining projects, so they need debt financing. As a result, Japanese commercial banks are becoming involved in such projects in the form of project financing. The area of project financing is new to Japanese banks, so they must recognize several of the risks of project financing before entering into this area.

In evaluating a project, several decision criteria must be considered. The Discounted-Cash-Flow-Rate-of-Return (DCFROR) method and the Net-Present-Value (NPV) method measure the profitability of a project. Since these methods consider the time value of money, they are superior to some conventional methods. The Payback Period method is useful as a risk indicator. Plotting a cash flow curve is also useful in understanding a project.

The main concern of a bank is the repayment of the loan, so it is necessary to consider repayment using the Cash Flow Debt Coverage Ratio (CCR).

Sensitivity analysis is one of the most effective tools for a bank to evaluating a project; the most sensitive factor discovered can be investigated more carefully.

The bank should always consider the leverage effect; borrowed money usually makes a project look better. It is suggested that the all-cash investment case should be considered in order to avoid a project which is unprofitable by itself.

The project evaluated in this thesis looks satisfactory on the basis of the analyses presented. But according to the sensitivity analysis, coal price is the most critical factor to the project. Therefore, it is recommended that coal prices be studied further. It is also possible to shorten the period of the loan. The author would conclude that the 13-year loan period, from the start of borrowing to the end of principal repayment, is perhaps uncommonly long for a typical commercial bank.

Finally, project financing requires not only evaluation techniques, but also the composite knowledge of a bank in such parameters as market analysis and loan experience. This kind of loan will often be a severe test for the evaluation capabilities of a typical commercial bank.

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