RESOURCE TAXATION AND PROJECT FEASIBILITY: THE MISIMA GOLD MINE,

Papua New Guinea

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Abstract

This paper is about the feasibility of a gold mine in Papua New Guinea (PNG), with particular emphasis on fiscal issues involved in a mining project. The study begins by considering the market for gold and a description of the technical aspects of the Misima gold mine in PNG. The financial analysis of the project covers both the total investment and the owners' perspectives. As grade selection is a significant issue in an extractive project, the case where the grade selection profile follows the path of discounted prices is also examined. A sensitivity analysis is performed on the parameters of the project that are likely to vary over time. The economic analysis is done after estimating the economic costs of capital, foreign exchange, and labor for the PNG economy. Results are also obtained for the case when the entire investment may be treated as incremental. The social analysis identifies the externalities generated by the project and assigns them to the various agents in the economy. A risk analysis is completed for those variables that are relatively uncertain and have a high impact on the project. Alternative forms of fiscal regimes prevalent in the mining sector and their effect both on the variability of the government revenue, as well as on the investor's earnings, are also considered. Finally, the tax-like disincentives caused by an overvalued exchange rate in the resource-owning countries are demonstrated.

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SECTION 1: CURRENT TRENDS IN GOLD MINING IN THE PACIFIC ISLANDS

Introduction

There has been an upsurge in gold mining activity in the Pacific islands. Papua New Guinea (PNG) is now the sixth largest gold producer in the non-communist world, after South Africa, Canada, USA, Australia and Brazil. Recently a series of significant and successful explorations have taken place in PNG. The Misima[1] mine has come into production; the Porgera, Hidden Valley, and Mt. Kare mines are expected to become operative by 1991; and the Lihir Islands, Wapalou, Laloki, Frieda, and Yendara mines are in advanced stages of development.

In neighboring country Fiji[2], the Emperor mine has undergone expansion, explorations are on at the Mt. Kasi site seeking reserves to sustain a 50,000 tonnes per year plant while production is expected to begin soon at the Nasoma mine. An agreement has been finalized between the government of Solomon Islands and the Cyprus Minerals company for the Gold Ridge deposit.

The present worldwide resurgence of interest in gold mining is the result of a combination of several factors. The overall demand of gold, which mainly falls in three categories: government purchases, private investment, and

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1. Source: Department of Mineral and Energy, Government of Papua New Guinea.

2 'The Gold Scene', a survey of currently active gold mines may be found in Mining Magazine, April 1988.

fabrication, has been going up steadily during the eighties with an annual average rate of 12 percent[3]. The cost of gold production, on the other hand, went up steadily from 1960 to 1983. This was mainly due to an increase in labor costs, higher prices for machinery, fuel and power and depletion of reserves near the surface. However, the recent innovations in gold recovery technology, viz. carbon-in pulp (CIP), carbon-in-leach (CIL), and heap leaching techniques are less capital intensive, and have lower operating costs. Since 1985, the average production costs have fallen and are expected to remain below $200 per troy oz over the next several years.

These developments have rendered the gold mining sector very attractive, particularly in contrast to other base metals that have faced a rather poor economic outlook ever since the collapse of the commodity boom in 1972-74. A new phase of exploration, expansion of existing capacity and new mine development has emerged. There has been a virtual 'gold rush' throughout the world. With the prospects of above-normal profits in the gold mining industry the resource owning governments, particularly of the developing countries, are keen to maximize their benefits from this sector.

Revenue Maximization

In Papua New Guinea, there has been an emphasis on maximization of revenue from minerals in general and gold in

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[3] For details of the recent trends in demand, price and production cost of gold see: Gold Supplement, Mining Journal Ltd. (1987), London; Annual Review of the World Gold Industries 1987, Shearson Lehman Brothers, London; IMF International Financial Statistics; and New Gold Projects and Prospects of the Western World, Mining Journal Ltd. (1986), London.

particular because of poor linkages[4] of mining to other sectors of the economy. At the same time, local markets for most mineral products, particularly for gold, are undeveloped. As a consequence, production is mostly exported. Both forward and backward linkages to a diversified manufacturing sector are largely absent because of the enclave nature of investments by multinationals and a lack of policies by the government to make it financially attractive for the mining companies to use domestic resources. It is usually not worth the resulting loss of tax revenue to require companies to generate significant linkages with other sectors in the economy. The policy of the government, therefore, has been to maximize revenue from mining activity and then to use these funds for the promotion of social infrastructure and other development activities.

Main Instruments for Raising Revenue

The main instruments employed by the PNG government for raising revenue have been corporate income taxes (35%), royalty (1.25%) on f.o.b./sales value of the metal product, and witholding taxes on dividends. With a view to sharing the windfall profits, the government has adopted a variation of the "Resource Rent Tax"[5] (35%) and has also opted to participate directly by having the right to purchase equity shares of up to thirty percent. It has exercised this right in the case of Bougainville and Ok Tedi, but shares have been limited to twenty percent.

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[4] Mining stimulates little economic activity in any other sector. See John Tilton, John Millet and Richard Ward 'Mineral and Mining Policy in Papua New Guinea', Institute of National Affairs, 1986.

5 See Hartwick, John M. and Olewiler, Nancy D. (1986); Garnaut, Ross and Clunnies Ross, Anthony, (1983); and Conrad Robert F. and Shalizi, Zmarak M. (1988) for a discussion of Natural Resource Rent.

The Misisma Gold Mine: An Appraisal

The gold mining activity in PNG is expected to increase in the coming years as more and more mines are developed and exploited. As the only benefit to the host economy is the revenue earned from the multinationals with whom the government has entered into contracts, fiscal issues are going to be of major concern to the government. The nature of the fiscal regime is also crucial to the investors as it affects both the net present value and the annual cash flows of their investment.

This study highlights two issues. First, it demonstrates how one should set up a financial and economic cost benefit analysis of a mining project. This is done using the Misima gold mine as a case study. Second, we use this case to analyze how alterantive fiscal regimes impact on the variability of the cash flow to the investor and the tax/ royalty earnings of the government. As the design of the fiscal regime is usually part of the policy process that determines if such mines are to be developed, the fiscal aspects are integrated into the feasibility study of the project.

SECTION 2: THE COST BENEFIT APPRAISAL OF THE MISIMA GOLD MINE

The Misima mine began to operate in 1989 and it has an expected life span of twelve years. The main product is gold. A small amount of silver is also produced as a byproduct.

Trends in Gold Prices

The price of gold, which sold for $35/troy ounce[6] for almost a quarter of a century during the Brettonwoods regime of fixed exchange rates, rose in an unprecedented manner beginning in the mid-1970's and peaking to an annual average of $612/troy ounce in 1980 in nominal terms. Although the gold price has been very volatile, it has since not gone below $317/troy oz (1985), which is in real terms still higher than three times the price prevailing in 1970. In such basic resource commodities twenty years is rather a short period for emergence of any particular trend, but gold prices have shown some cyclicality which is best approximated by a fifteen year time period. Therefore based on the prices prevailing between 1970 to 1989, a fifteen year cycle has been adopted for projection of gold prices. The rate of expected world inflation has also been incorporated in the future price trend. The projected prices are as follows:

Year	1989	90	91	92	93	94	95	96	97	98	99	00
Price[a]	411	450	480	501	512	515	511	505	502	504	515	536

[a](Kina[7] per troy oz)

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[6] Troy ounce is a system of weights used for gold and silver. One troy ounce equals approximately 31.1 grams.

[7] Kina is the PNG currency and, with the present exchange rate, one Kina is approximately equal to 1.06 US $.

As silver is a minor byproduct, its price (K125 per Kg. in 1988), is presumed to go up with the rate of inflation in a straight line fashion.

Technical Features of the Mine

The Misima gold mine[8] is located in Misima island of Papua New Guinea. Alluvial gold was first discovered in the area in 1888 and underground mining was carried out by various companies up to 1942. There has been no mining in the postwar period. Prospecting authority was first granted for the present site in 1977 to Placer Niugini Pvt. Ltd., which is now the owner of the mine. To date the government has not exercised its right of equity participation in this mine.

This is an open pit mine with an estimated ore reserve of 62 million tons. Gold is the main product with an average grade of 1.35 gram/ton and a cut-off grade[9] of 0.7 at current prices. Silver is the byproduct with an average grade of 20 gram/ton. The milling capacity is 4.5 million tons per year, which is proposed to be expanded to 6 million by the sixth year. Waste disposal is through a nearshore dump for soft waste and land dumps for hard waste. Submarine disposal will be adopted for disposal of tailings.

The present mining project was approved by the government in August 1987 and construction began immediately

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[8] All the data is courtesy Department of Minerals and Energy (DME) of the government of Papua New Guinea. For reasons of confidentiality between the DME and the mining companies, part of the data used is either an approximation or is in an aggregated form. This is particularly true of operating costs and the financial structure of the mine.

[9] It is the lowest grade (metal content in grams/ton) that is economical to extract at a particular price of the metal.

thereafter. The project is therefore analyzed ex ante as of 1988 when major investments were made. All prices and costs are in the PNG currency Kina.

The main components of investment are:

Infrastructure	5%
Machinery and equipment	85%
Installation	10%

Eighty five percent of machinery and equipment is imported. All imported capital goods are subject to a tariff of 10 percent on their c.i.f. value. The yearly cost of maintenace and repair is 5 percent of the total cost of investment. Buildings and machinery are presumed to depreciate at the rate of 10 percent per year. The capitalized exploration cost is taken to be 14.4 million, based on a world average of exploration cost for mines of this size.

The expected world and domestic inflation rates are estimated to be 5.5 and 5 percents respectively. The labor productivity in PNG has remained constant over the past several years. It is assumed that the same trend will continue.

2.1 Financial Evaluation

Parameters of Analysis

(a) Financial:

The total investment on development of the mine is K 160 million in 1988 prices. In the mining sector, the government allows a maximum debt component of 75 percent of total investment. In this case a 60:40 debt equity ratio is assumed and a sensitivity analysis is done to determine the impact of a change in the ratio. Return on equity and cost of borrowing are

taken as 20 and 12.01 percents respectively [10]. This yields a real financial discount rate of 9.72 percent[11].

(b) Production Plan:

For the production plan, data from the Department of Minerals and Energy was modified to some extent because the entire amount of gold ore that is economical to extract is not exhausted if the department's plan is followed. Either the life of the mine or the capacity of the plant has to be adjusted to extract the gold fully. To reconcile this, the initial milling capacity of 4,500 million tons of ore per year is upgraded to 6,000 million tons from 1996. This corresponds to the production plan outlined for this mine in the World Bank Report on 'Mining Operations in Oceania' (1987). Recovery rates of 94% for gold and 74% for silver have been used, based on estimates in this World Bank report. The production plan is as follows:

Year	1989	1990-93	1994-95	1996-99	2000
Capacity ('000 tons)	3500	4500	5500	6000	5500

(c) Input Costs:

Input prices are presumed to remain constant in real terms so that their escalation in future years simply follows the rate of inflation. Based on the experience over the last decade the real productivity of labor is assumed to remain constant. Hence

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[10] Return on equity in the mining sector for PNG is not available directly. An estimate based on information from other similar economies was made. The rate of borrowing for the investor is estimated from data on interest rates for PNG.

[11] The discount rate of 9.72% represents the real private opportunity cost of capital. It is the weighted sum of the real rate of interest on debt (6.67%) and the real return on equity (14.29%), weights being in proporion to the debt/equity ratio: 14.29*0.6+6.67*0.4 = 9.72% real.

nominal wages will increase at the rate of domestic inflation. The total operating cost per ton of ore for this mine is K 8.18. The main components of operating costs[12] and their share are as follows.

Labor	20%
Raw material	32%
Fuel and power	15%
Miscellaneous	33%

Fifty percent of raw materials are imported and are subject to a tariff of 10 percent.

For calculation of the working capital, accounts receivable is taken as 10% of sales, inventories as 15% of raw material, accounts payable as 10% of manufacturing costs, and cash balance as 2% of the sales revenue.

(d) Tax Regimes:

The financial analysis has been done after taking into consideration the taxation laws and special provisions like accelerated depreciation rules, loss carry forward etc. as prevalent in PNG. Gold mining in PNG is subject to a royalty of 1.25% on FOB value of exports and a corporate income tax of 35%. An additional profits tax at the rate of 35% is payable when the rate of return on a cash flow basis exceeds a designated rate of return which is 20% or the US prime rate plus 12 percentage points.

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[12] The percentages for the allocation of expenditures rather than actual figures were provided by the PNG government. The expected rates of increase of the various components were not available separately. They are, therefore, assumed to go up at the rate of inflation.

Allowable deductions for tax purposs include exploration and capital expenditures. The yearly tax deduction for exploration expenditure is calculated by dividing the allowable expenditure by five or the life of the mine, whichever is less. Similarly the deduction for capital expenditure is divided by the lesser of the life of the mine or ten. There is a special provision for non-replacement plants installed after production has commenced, which allows 25% of the cost to be deducted in the year of purchase. Losses may be carried forward for a period of sven years.

There is a provision for accelerated depreciation if the net income in any year during the investment recovery period is less than the target income, which is 25% of the initial capital investment. The investment recovery period extends so long as the accumulated gross project income is less than the initial capital investment. The amount allowed under this provision is the least of:

(a) the amount required to reduce the income tax payable for the year to achieve the target income,
(b) residual exploration and capital expenses, and
(c) the remaining taxable income of the taxpayer.

Results

The proforma cash flow for the project from the total investment point of view is given in table 1 below:

Table 1

Pro Forma Cash Flow Statement - Total Investment Perspective

(All figures in nominal terms in million Kina)

Year	1987	'88	'89....93	'94	'95	'96	'97...2000
Infl. Index		1	1.05	1.28	1.34	1.41	1.48	1.55	1.8
INFLOWS:									
Sales			74	122	142	132	134	125	75
Change in A/C Receivable			-9	-.6	-2	1	-.2	1	12
In Use Value (Equipment)									47
Total Inflows:			65	121	140	133	134	126	134
OUTFLOWS:									
Cost of Sales[13]			29	45	57	60	69	73	77
Investment	18	156	9	72	14	14	15	16	0
Change in A/C Payable			-2	-.2	-1	-.2	-.7	-.3	6
Total Outflow	18	156	36	117	70	74	83	89	83
NCF BEFORE TAXES	-18	-156	30	5	69	59	50	38	50
Royalty			.9	1.5	1.8	1.7	1.7	1.6	.9
Income Tax			6	14	12	12	9	5	8
NET FINANCIAL CASH FLOW	-18	-156	23	-11	55	45	39	31	41

[13] It includes labor, fuel and power, raw material and miscellaneous expenses.

All items in the above proforma cash flow statement are subsequently deflated by the domestic inflation index to 1988 price level. The net cash flow thus obtained is discounted by 9.72%, the real financial discount rate to yield a positive NPV. Table 2 shows the extracts from the results:

Table 2

Net Present Value	= K 12.48 million,
IRR	= 11.09%
PV of Royalty Collection	= K 7.58 million,
PV of Income Tax Revenue	= K 57.06 million,
PV of Total Revenue	= K 64.65 million,

The NPV is higher when the project is examined from the owner's perspective. Table 3 shows the extracts from the results of the analysis:

Table 3: Pro Forma Cash Flow Statement - Owner's Perspective

Year	1987	'88	'89....93	'94	'95	'96	'97...2000
NCF	-18	-60	23	-31	35	25	19	11	20

(million Kina)

Discount Rate = 9.72%

Net Present Value = K 17.06 million

IRR = 14.89%

NPV When Grades Extracted in Order of Discounted Prices

Economic theory suggests that the intertemporal grade selection, i.e. the order in which grades are selected for extraction in different time periods, corresponds to the profile

of discounted prices[14]. The firm should take the highest grade of ore when the discounted expected price is highest; lower grades sequentially allocated in a like manner until cut-off grades are reached. The notion that best quality ores should be exhausted first does not lead to an optimum result in this situation and, if followed, will lead to lower net present value.

To illustrate this point, the projected prices are discounted by the real rate of discount. The ore grades are redistributed in such a manner that the highest ore grade is mined during the period of highest discounted price and all the grades are reallocated in a declining order. This has been done for gold grades and the resulting NPV is higher. In fact, this would be the highest NPV that may be obtained with any set of prices. The result may be fruitfully used if prices are projected realistically and the mine's geology physically permits an extraction profile that follows this rule. Table 4 shows the extracts from the results:

Table 4:NPV With Extracted Grades in Order of Discounted Prices

Year	1987	'88	'89....93	'94	'95	'96	'97...2000
NCF	-18	-156	30	-11	55	45	39	32	41

(million Kina)

Discount Rate = 9.72%

Net Present Value = K 12.97 million

IRR = 11.17%

[14] Full analysis and mathematical derivation may be seen in Conrad, Robert F.; Gillis, Malcolm; and Jenkins, Glenn P. 'Taxation and the Development of the Mining Sector in Developing Countries: A Plan for Future Research', paper presented in seminar to World Bank August 18,1980.

Sensitivity Analysis

A sensitivity analysis has been carried out to determine the impact of changes in key variables on NPV, IRR, Royalty collection, and the Income Tax revenue to the government. The variables tested are the debt equity ratio, the rate of royalty, income tax, domestic inflation, and price of gold. The results are analyzed below.

Debt - Equity Ratio

The debt equity ratio for the project is allowed to vary between zero and hundred percent. Gold price, royalty rate, and income tax rate are held constant. The results are summarized in table 5.

Table 5: Impact of Variation in Debt-Equity Ratio

D/E Ratio	NPV	IRR	PV Tax	PV Royalty
0%	-32.7	8.9%	74.1	7.6
20%	-19.2	9.6%	68.4	7.6
40%	-4.2	10.4%	62.7	7.6
60%	12.5	11.1%	57.1	7.6
80%	31.1	11.8%	51.4	7.6
100%	51.8	12.5%	46.0	7.6

At very low rates of debt, the financial NPV is negative, but the tax collections are higher. This is caused by the deductibility of interest expense for income tax purposes. As the firm becomes more and more leveraged, the income tax liabilities begin to fall and (with a constant discount rate) the financial NPV rises. A high percentage of debt, however, entails the risk of bankruptcy.

The present value of tax revenue falls as the debt equity ratio rises. This is the result of deductibility of interest

expenses before computation of income tax. With higher percentages of debt, interest payments mount and the net taxable income declines.

Royalty Rates

The impact of changes in royalty rate (from 0% to 20% of sales value), keeping other variables like rate of income tax, debt-equity ratio, rate of inflation, and gold price constant, are examined next. The results are presented in table 6.

Table 6: Effect of Changes in Royalty Rate on NPV and Tax Revenue

Royalty	NPV	IRR	PV Tax	PV Royalty
0%	17.4	11.7%	59.7	0.0
2%	9.5	10.7%	55.5	12.1
3%	5.5	10.2%	53.4	18.2
5%	-2.6	9.1%	49.3	30.3
8%	-14.7	7.4%	43.3	48.5
10%	-22.8	6.2%	39.2	60.7
15%	-43.1	3.0%	29.3	91.0
20%	-64.0	-1.0%	19.7	121.3

The cash flow becomes marginally negative in 1999 when royalty is raised to 4%. It becomes negative in 1998 when royalty goes up beyond 20%.

The royalty rate of 1.25% prevailing in Papua New Guinea, happens to be one of the lowest in the world. It is found that the cash flow becomes negative in the eleventh year when royalty is raised to 4%. It may, therefore, appear that highgrading[15] is

15 Highgrading is the phenomenon of leaving the low grade ores in the mine when the extraction costs become high as compared to the price of the metal. It may be caused by a fall in price of the output or a rise in costs.

being caused by a royalty of 4%. A look at the net cash flow before royalty and taxes, however, shows that this is more because of the low prices prevailing in that year due to the cyclical nature of prices rather than the effect of royalty. In fact, the cash flow in the eleventh year is only marginally positive even before imposition of the royalty. The cash flow in the tenth year gets negative only when the royalty rate exceeds 20 percent.

Economic theory suggests that royalties cause highgrading forcing the firm to leave the marginal ores in the mine[16]. With the present assumptions, highgrading is not perceived as a serious problem even for fairly high rates of royalty.

Income Tax

The effect of changes in rates of corporate income tax are analyzed by varying the tax rates from 10% to 70%. Rates of inflation, gold prices, debt-equity ratio, and royalty rates are kept invariant for this part.

As the income tax rate rises, NPV falls and government revenue goes up. At a 40% tax rate, NPV becomes negative. There is no correlation between the changes in income tax rate and the collection of the royalty, which remains fixed. Cash flow does not turn negative in any year during the life of the mine. As expected, income taxes capture only profits and there is no incentive created for highgrading. The results of the analysis are summarized in table 7.

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[16] For a discussion of economic effects of Severance Taxes, including highgrading, see

A.O.Lockner, "The Economic Effect of Severance Tax on Decision of Mining Firms" (Natural Resource Journal 1965)

Malcolm Gillis et al. Taxation and Mining (Ballinger Publishing Company, Cambridge, Massachusetts, 1978)

Table 7: Impact of Different Income Tax Rates

Income Tax	NPV	IRR	PV Tax	PV Royalty
10%	52.0	16.2%	16.5	7.6
20%	36.6	14.1%	32.9	7.6
30%	20.5	12.1%	49.1	7.6
40%	4.5	10.1%	65.0	7.6
50%	-11.2	8.0%	80.8	7.6
60%	-26.8	5.8%	96.4	7.6
70%	-42.2	3.6%	111.7	7.6

Royalty vs Income Tax

Although they are often imposed together, a clear trade-off may be seen between the royalty collected and the income tax revenues paid to the government. As the rate of royalty goes up, the income tax collection falls, but at a slower pace than the rise in the amount of royalties. A higher rate of royalty, therefore, means a higher sum of income tax and royalty revenues. Total collections from royalty and income tax also increase if higher income tax rates are applied. The sum of tax revenue, royalty collections, and financial NPV of the project is a constant sum for different combinations of tax and royalty rates as long as highgrading does not take place.

Domestic Inflation

As the case is designed, the rate of inflation in Papua New Guinea is at par with the world inflation. When the domestic inflation is allowed to go up, in a situation when the government holds the nominal exchange rate constant, NPV begins to fall and both the royalty collection and tax revenue decline. This may be seen by the results presented in table 8. The effect is primarily caused by rise in cost of domestic inputs. The results are particularly sensitive to this parameter because the entire product is exported while sixty-eight percent of inputs are

domestic. We return to this issue while discussing the effect of overvalued/undervalued exchange rates which the Pacific island countries maintain as a matter of policy.

Table 8: Effect of Changing Domestic Inflation on the Project

Domestic Inflation	NPV	IRR	PV Tax	PV Royalty
0%	123.0	21.2%	101.2	10.1
2%	76.6	17.6%	82.9	9.0
5%	20.2	12.0%	61.0	7.8
8%	-26.1	5.3%	46.0	6.8
10%	-52.7	-1.3%	39.2	6.2
15%	-106.1	-169%	27.6	5.1

Gold Prices

Finally, the impact of variations in gold prices on the project is seen by changing the gold price in the year 1988. This changes the price cycle in subsequent years. Extracts of the results are presented in table 9.

Table 9: Impact of Variaton in Gold Prices

Gold Prices (US $ 1988)	NPV	IRR	PV Tax	PV Royalty
300	-99.6	-44.7%	6.3	5.5
325	-79.8	-6.6%	14.0	5.8
350	-60.3	-0.9%	22.0	6.2
375	-41.2	3.1%	30.5	6.6
400	-22.4	6.2%	39.4	6.9
425	-3.9	8.9%	48.7	7.3
450	14.5	11.4%	58.2	7.6
475	32.5	13.5%	68.2	8.0
500	50.2	15.5%	78.4	8.3
525	68.0	17.5%	88.7	8.7
550	85.9	19.3%	99.0	9.1

For analyzing the effect of changes in gold price, royalty, income tax rate, operating cost, and debt equity ratio are kept unchanged. As expected, net present value of the project, income tax revenue and royalty amount all go up as the gold prices increase.

2.2 Economic Evaluation

For this part of the analysis, the economic opportunity cost of foreign exchange (EOCFX), capital (EOCK), and labor (EOCL) are estimated first. For lack of adequate data, conversion factors for different categories of labor could not be estimated separately.

The Economic Discount Rate

This is the social opportunity cost of capital and is the weighted sum of the marginal productivity of capital in the private sector and the rate of time prefernce for consumption including the cost of foreign borrowing[17]. The data used [18] for demand and supply of funds for Papua New Guinea is given in table 10.

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[17] Jenkins G.P. and Harberger A.C. Manual on Cost Benefit Analysis of Investment Decisions, Harvard Institute for International Development, Chapter 12.

18 The demand and supply elasticities are approximations based on information from similar economies, while figures on nominal return and share in capital market are from 'Quarterly Economic Bulletin' PNG (Sept 1989 issue). The data on foreign borrowing is from 'Papua New Guinea: Economic Situation and Outlook' Feb. 1989. In case of foreign borrowing, interest rate is further adjusted for elasticity of supply.

Table 10: Demand and Supply of Funds in PNG

Rate of Inflation 5%

Demand for Funds

Sectors	Agri.	Manufact.	Mining	Govt.	Housing
Nominal Return	14.5%	14.5%	14.5%	14.5%	14.5%
Taxes	0%	30%	35%	0%	15%
Real Return (Pi)	9.5%	15.7%	17.3%	9.5%	12.1%
Demand Elasticity(N)	-1	-1	-1	0	-1
Market share (I/S)	13.3%	48.9%	0.9%	1.6%	10.8%
N*I/S	13.3%	48.9%	0.9%	0%	10.8%
Pi*N*I/S	0.01	0.08	0.00	0.00	0.01

Supply of Funds

Sectors	Business	Govt.	Household	Foreign
Nominal Return	14.5%	14.5%	14.5%	20%
Taxes	30.0%	0.0%	9.3%	17%
Real Return (r)	5.1%	9.5%	8.2%	19.9%
Supply Elasticity(E)	0.5%	0.0%	0.5%	2.0%
Market share (s/S)	44.9%	7.8%	33.7%	13.6%
E*s/S	22.5%	0.0%	16.9%	27.3%
r*E*s/S	0.01	0.0	0.01	0.05

EOCK=[Sum E*(s/S)*r-Sum N*(I/S)*Pi]/[Sum E*(s/S)- Sum N*(I/S)]
= 13.07

Economic Opportunity Cost of Foreign Exchange

The following data, presented in table 11, are used for foreign exchange demanded and supplied and revenues from export duty and import duties (all figures in million Kina) for the period 1982-88 for Papua New Guinea[19] :

[19] Data sources for this part are the same as those for the economic opportunity cost of capital above.

Table 11: Value of Imports/Exports and Trade Tax Revenues in PNG

Year	1982	1983	1984	1985	1986	1987	1988
Import duty	128	140	159	166	188	213	224
Imports (cif)	887	945	971	1006	1037	1106	1194
Exports Tax	5	5	13	13	14	17	16
Exports (fob)	571	688	822	926	1001	1135	1253
Tariff Rate (T)	14%	15%	16%	16%	18%	19%	19%
Export Tax (tx)	0.8%	0.7%	1.6%	1.4%	1.4%	1.5%	1.3%

Elastitcity of supply of export (Ex) 0.5
Elasticity of demand of import (Ni) -1.5

The Economic Opportunity Cost of Foreign Exchange is estimated with the help of the following expression[20]:

$EOCFX = e_m * [Ex*(1-tx)-Ni*(1+T)Qi/Qx]/[Ex-Ni*Qi/Qx]$

where Qi and Qx are the quantities of foreign exchange demanded and supplied.

C.F. ($EOCFX/e_m$)	1.12	1.12	1.12	1.12	1.13	1.14	1.14

Average Conversion Factor or Foreign Exchange Premium = 1.13
There are no quantitative restrictions on exports/imports in PNG and therefore tariff reflects all the premium.

Economic Opportunity Cost of Labor

In the mining sector, three groups of workers are identified: expatriates, skilled, and unskilled. Their number and wages are

[20] For a discussion of the concept and a complete derivation of this expression, see Jenkins G.P. and Harberger A.C., Manual on Cost Benefit Analysis of Investment Decisisons, HIID, Chapter 10.

shown in table 12 below[21].

Table 12: Number and Wages of Different Categories of Labor

Type of Labor	Number	Weekly Wage (Kina)	Income Tax	Economic Wage (Kina)
Expatriates	785	320	28%	238
Skilled	2619	84	9%	80
Unskilled	106	18	0%	12

Expatriate wage in other sectors	201
Share of income repatriated (R)	25%
Skilled labor wage in urban areas (Wu)	34
Rural Wage (Agriculture Sector) (Wr)	12

Average Financial Wage =	135
Average Economic Wage =	113
Conversion Factor =	0.83

Economic opportunity cost of unskilled labor[22] is the wage prevailing in the rural agricultural sector from where they are drawn to the mine. The economic wage of the skilled labor that migrates from the urban sector and the expatriates are given by the following equations:

Skilled EOCLs = Wr - (Wr - Wu) * tax

Expatriate EOCLe = We * (1-te) * (1-R) + We * (1-te) *R * Ee/Em

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21 Data Source is "The National Manpower Assessment" by Morris, Ian and Pourhosseini, M. in 'Post Independent Economic Development in Papua New Guinea' ed. Dahanayake, P.A.S. (Monograph 19 of (IASER).

22 For a discussion on economic opportunity cost of labor of different kinds, see chapter 13 of the Manual on Cost Benefit Analysis of Invetment Decisions, HIID.

where We is the wages paid to the expatriates on the project and Ee/Em is the foreign exchange premium.

Proforma Cash Flow Statement - Economy's Perspective

In order to get to the economic cashflow, the financial cash flow is adjusted in the following steps:

(1) There is no tax or subsidy on exports of both the products, gold and silver. The sales are simply adjusted for the foreign exchange premium by multiplying the financial revenues by the Economic Opportunity Cost of Foreign Exchange.

(2) There is a ten percent tariff (average) on raw material and capital goods. The tariff is taken out, being merely a transfer, and the value is then adjusted for foreign exchange premium again, just as in the case of sales revenue.

(3) The expenditures on labor are also converted to their economic value by multiplying them with the conversion factor for labor.

(4) The loan, repayment of the principal and the interest payment are all excluded, being merely transfers from one part of the economy to another.

(5) The net cash flow is now discounted with the economic opportunity cost of capital.

With these changes, the economic proforma cash flow appears as in table 13.

Table 13: Pro Forma Cash Flow Statement - Economic

(All figures in nominal terms in million Kina)

Year	1987	'88	'89....93	'94	'95	'96	'97...2000
Infl. Index		1	1.05	1.28	1.34	1.41	1.48	1.55	1.8
INFLOWS:									
Sales			83	137	160	149	151	141	84
In Use Value									48
Accounts Receivable			-10	-1	-3	1	0	1	13
Total Cash Inflow			73	136	157	150	151	142	145
OUTFLOWS:									
Cost of Sales			28	43	56	59	67	70	75
Investment	19	158	9	73	14	15	15	16	0
Accounts Payable			-2	0	-1	0	-1	0	6
Royalty			0.9	1.5	1.8	1.7	1.7	1.6	0.9
Total Cash Outflow	19	158	36	118	71	76	83	88	82
NET ECONOMIC CASH FLOW	-19	-158	37	18	86	75	67	55	63
NCF (Real)	-20	-158	36	15	65	54	46	35	35

Discount Rate = 13.07%

Net Present Value = K 108 million

IRR = 26.29%

The net present value is quite high as compared to the financial part. This is a measure of the gain to the whole economy.

Incremental Investment

The investment in the mining sector has some special features. Most of the investment comes from outside the country and the economic benefits presented in the above analysis do not reflect the true economic benefits to the country. The benefits derived by the company, for example, may not be really a benefit to the host country. Most of the earnings would be repatriated in due course to the home countries. On the other hand, taxes, tariffs etc. that have been omitted as being merely transfers, are the only benefit to the host country. To incorporate this situation, the entire investment in the mining sector may be treated as incremental to the host economy. With this assumption, to get the true economic value to the host country, the financial net cash flow is subtracted from the economic one so that all the investment is netted out and only the cash flow for the economic benefit from the incremental investment is left. The results are given in table 14:

Table 14: Proforma Cash Flow Statement - Incremental Investment

(All figures in real terms in million Kina)

Year	1987	'88	'89....93	'94	'95	'96	'97...2000
NCF	-.22	-2	14	24	23	22	19	15	12

Discount Rate = 13.07%

Net Present Value = K 119.16 million

IRR = 226%

It may be seen that the gains to the economy in this case are higher. It is intuitive that the gain now is what the host government realizes from taxes, tariffs, and royalties and the results correspond to this.

2.3 Social Evaluation

A project generates externalities when its financial inflows and outflows differ from their respective economic values. These externalities are first identified, then presented in net present value terms and, finally, are allocated to the different actors in the economy. This shows who is gaining or losing from the project. There are basically four ways in which a project can generate externalities:

Economic Income/Expenditure in Related Areas

The project may generate economic income and/or incur economic expenditure that is not taken into account in the financial projection. In case of the mining sector in a developing country like PNG, there is little positive exteranlity because of poor linkages between mining and other sectors of the economy.

Intra Sectoral Effects

To the degree that the project's cash flow is going to be non-incremental to the economy, the project captures net revenues from existing similar projects in the economy. In the gold mining sector in Papua New Guinea, this is not the case as the cash inflows from a particular mine will be incremental to the economy.

Distortions in Economy

This is caused by distortions like taxes, subsidies, price controls, and mononpolies. Evidently, this type of externality is relevant in the present case.

Foreign Exchange Premium

The premium on foreign exchange, which is credited or charged to the project, is also a source of externality. This is caused by the divergence between the market price of

foreign exchange and its economic value.

Results

The externalities generated by the project are reflected in the difference between financial and economic cash flows. To calculate these, each line of the financial cash flow is subtracted from the corresponding line in the economic cashflow. The net present value is then calculated using the economic discount rate. The externalities are then allocated to the various agents involved in the project.

As brought out in the preceding discussions, most of the externalities in this case occur because of taxes, tariffs, and the premium on foreign exchange. All these externalities represent a net revenue gain and accrue to the government. The only other group that gains substantially is labor, as it gets a financial wage which is larger than its economic value.

In table 15, the externalities are attributed to the various actors in the economy. The present value of externalities, discounted at the economic discount rate should equal the difference of NPV economic discounted at the economic discount rate and the NPV financial discounted at the economic discounted rate. This reconciliation is also shown at the end of the table.

Table 15: Distribution of Externalities

	Total	Govt.	Labor
INFLOWS:			
Sales	66.48	66.48	
Salvage Value	0.09	0.09	
OUTFLOWS:			
Labor	7.15		7.15
Raw Material	-0.51	-0.51	
Capital Investment	-3.19	-3.19	
Working Capital	-1.23	-1.23	
Corporate Tax	50.37	50.37	
PV Externalities (Economic Discount Rate - EDR)			K 119.16M
NPV Economic (EDR)			K 108.00M
NPV Financial (EDR)			(K 11.16M)
Reconciliation: $NPV^e(e)-NPV^f(e) = 108+11.16 = 119.16M = PV^{ex}(e)$			

2.4 Risk Analysis

Three variables - gold price, opertaing costs, and domestic inflation - that are relatively uncertain and have a high impact on the project are tested for risk[23]. Probability distribution and range limits assigned to these variables are as follows:

Risk Variable	Probability Distribution	Minimum Value	Maximum Value
Gold Price	Normal	$400/t oz	$500/t oz
Operating Cost	Triangular	K 8/ton	K 12/ton
Domestic Inflation	Triangular	2%	10%

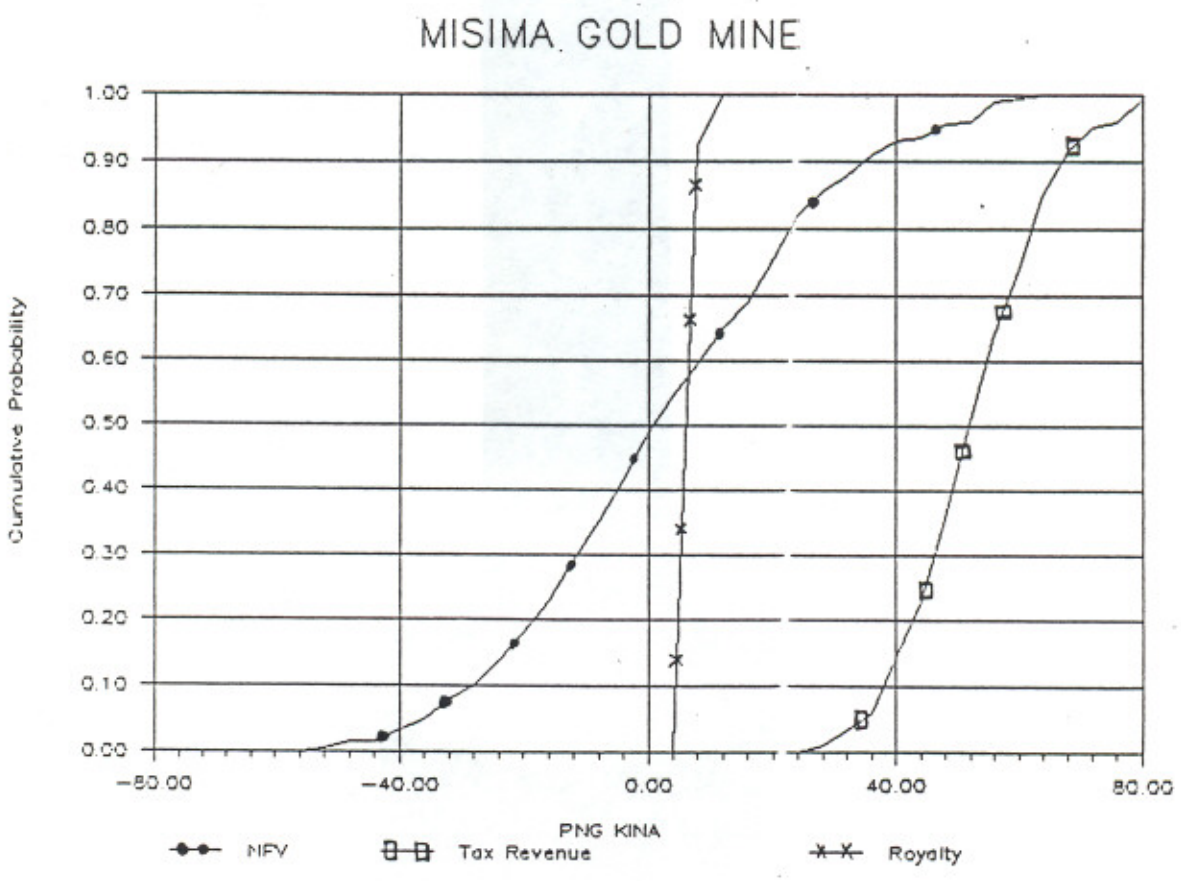
[23] Risk Analysis has been done using "RiskMaster", a program developed by Savvakis C. Savvides. See "Risk Analysis in Investment Appraisal", HIID discussion paper 276 (1988).

The results of the analysis are shown in the table 16:

Table 16: Risk Analysis Results

	NPV	Tax Revenue	Royalty
Expected Value	2.66	52.37	7.63
Standard Deviation	24.15	11.29	0.24
Minimum Value	-54.86	24.56	7.06
Maximum Value	60.83	80.08	8.22
Prob. of Negative Return	49%	0%	0%

The expected values of NPV, tax revenue and royalty collection are all positive. The spread of both the NPV and the tax revenue



are substantial, but the royalty collections are quite steady. As shown in the graph, the NPV is quite responsive to the risk, primarily because of the likelihood of operating costs going up in future while the prices of gold remain confined to a narrow band as they are determined by the world market.

A summary of the results of the financial analysis is presented in table 17 on the following page.

Table 17: Results of Financial, Economic and Social Analyses
(All figures in 1988 prices)

Financial	
Discount Rate	9.72%
(a) Total Investment Point of View:	
(i) Net Present Value	K 12.48M
(ii) Internal Rate of Return	11.09%
(iii) Present Value of Income Tax Revenue	K 57.06M
(iv) Present Value of Royalty	K 7.58M
(v) Present Value of Total Tax Revenue	K 64.65M
(b) Grades Adjusted To Discounted Prices:	
(Total Investment Point of View)	
(i) Net Present Value	K 12.95M
(ii) Internal Rate of Return	11.17%
(c) Owner's Point of View:	
(i) Net Present Value	K 17.06M
(ii) Internal Rate of Return	14.89%
Economic	
Discount Rate	13.07%
1. Foreign Investment Non-Incremental	
(i) Net Present Value	K 108.00M
(ii) Internal Rate of Return	26.29%
2. Foreign Investment Incremental	
(i) Net Present Value	K 119.16M
(ii) Internal Rate of Return	(226%)
Social	
(i) PV Externalities	
(Economic Discount Rate - EDR)	K 119.16M
(ii) NPV Economic (EDR)	K 108.00M
(iii) NPV Financial (EDR)	(K 11.16M)

SECTION 3: FISCAL REGIMES AND OTHER TAX-LIKE INCENTIVES

3.1 Impact of Taxation on a Mining Firm

While taxation of the mining sector is vital to the government for the purposes of raising revenue in order to carry out expenditures, it is equally important from the point of view of investors who face a very long gestation period for their investment in this sector. As profit maximizers, firms respond to fluctuations in costs of inputs and prices of outputs in the short run, and to changes in net-of-tax rate of return on investment in the long run.

In developed countries the mining firms are usually subject to the general laws of the land and marginal changes may be made to cover some specific issues only (preventing damage to the environment, for example). In developing nations, however, the terms governing the relationship between the host country and the foreign investor are generally set forth in ad hoc agreements[24] . This is primarily because of the major role that the operations of the foreign company play in the general economic development of the country. The output of the mining sector in developing countries constitutes a significant part of the gross domestic product and the revenue generated from extraction of minerals is a major portion of the national budget. In such a situation, governments find it more attractive to have individual agreements tailored to the special circumstances of the country. As a result, in many resource owning countries tax regimes are designed for particular projects and are laid down in the respective mining contracts. Therefore, the different forms of taxation and their impact on the government as well as the

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[24] See Smith, N. David and Wells, Louis T.; "Negotiating Third-World Mining Agreements" for a discussion on the role of the mining sector in the economy of the developing countries (including PNG) and the need for ad hoc agreements.

investors are included as part of this study.

Taxation affects the operations of a mine in several ways. It may change the time profile of extraction, that is the time when a particular ore quality and quantity will be extracted. It may also change the level of economically recoverable reserves or the "cut-off grades", which means that some operating mines will close while other low grade ones will not open. A firm that is considering investment in mining operations will treat any form of taxation as an additional cost of doing business in that region. The present value of the cash flow, and consequently of the mine, is reduced by the amount of taxes paid[25]. Increased tax liability, therefore, makes investment less attractive. This tends to decrease the size of investment in the mining sector in the long run and, as a result, the exploration and development of future mines also decline.

Finally, taxes are a central variable in determining the variability of the cash flow of the mine that accrues to different economic agents, e.g. the investors, land owners, state, and central government. Period to period variabilty of cash flows is a cost in itself, especialy to developing countries like those in the Pacific islands, where revenue from the mineral sector is a major part of the government budget. In the following section, the variability of government revenues and the cash flows occuring to the investors are examined under different tax regimes.

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[25] If the size of investment is I, Pi_t and T_t are profit and tax in time period t respectively, and d is the rate of discount, NPV with and without taxes is as follows:

$$NPV \text{ (without tax)} = - I + Sum_t \; Pi_t / (1+d)^t$$
$$NPV \text{ (with tax)} = - I + Sum_t \; (Pi_t - T_t) / (1+d)^t$$

3.2 Variability of Government Revenue and Investor's Cash Flow Under Different Fiscal Regimes

The cash flow of the mine is now subjected to alternate forms of taxes and the results analyzed. The rates of different taxes, however, have been adjusted so that the total real present value of tax revenue to the government and net present value of the mine remain the same as in the base case with 1.25% royalty and 35% of income tax. To compare the variability of both the government tax revenue and the investor's cash flow, the coefficient of variation (CV), which is the standard deviation normalized by the mean, has been calculated. The results of this analysis have been summarized in Table 18 on page 39.

Unit Royalty on Ore extracted[26]

A unit royalty of K 2.49 per ton of ore extracted yields the same results in terms of government revenue and NPV as the base case. Here the variation in tax revenue from year to year arises because of the change in quantity extracted or the change in capacity. It remains unaffected by changes in the price of output or of any input. The revenue stream is quite steady and the coefficient of variation is very small (0.08) as compared to the CV of revenue streams in the other alternatives under consideration. The earnings of the mine, net of tax, shows a good deal of variation and has a coefficient of variation of 6.22.

As the royalty remains fixed in nominal terms, it is seen that the real value of revenue falls even when the production capacity is the same (years 1990 to 1993, 1996 to 1999, and 1994-95, 2000). Thus, the miner may reduce the present value of taxes by changing the extraction profile of the ore quantity.

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[26] This is a tax on per unit of the ore extracted. It adds to the cost of extraction, changes the extraction and grade selection profiles and causes highgrading. The advantage, however, is in its administative simplicity.

Unit Royalty on Output[27]

A single royalty of K 1,609 per kilogram of gold produced, gives the base case revenue and net present value. The variation in the revenue is now caused by a change in capacity over the life of the mine as well as by varying the grades of the ore extracted. The coefficient of variation of the revenue stream is 0.24 which is higher than that observed in the case of unit royalty on quantity of ore. Just as in the previous case, the revenue falls in real terms over the years. There is again an incentive to reduce the present value of taxes paid by changing either the quantity or the quality (grade profile) of ore extracted. The earnings, net of royalties, show a smaller variation (CV 5.92) as compared to the case with the fixed royalty on ore.

Ad Valorem Royalty[28]

A single royalty of 11% of the sales price is equivalent to the previous two cases. The changes in revenue are now due to changes in year-to-year prices and the quantities of output produced. The variability of government revenue and the mine's earnings are almost at par with that in the case of unit royalty on output.

Income Tax

A single income tax of 38% yields the same government revenue as the base case. Revenue now is a function of the prices of both the output and the different inputs. It therefore shows a considerably higher variation from year to year (CV 0.64). The net of tax earnings of the mine are less variable (CV 5.42) than in the cases of royalty.

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[27] This is a unit tax on the mineral content. Its impact is similar to that of the unit tax on the ore.

[28] This tax is a fixed proportion of the price of the mineral. It affects the extraction profile but not the grade selection profile. It is also simpe to administer.

Variable Royalty[29]

A single royalty that changes with the price of the output is applied in this case. The rates are kept at 6% of the gold price up to the price level of K 500 an ounce, and 13% when the price is more than K 500 an ounce. In this case, the government revenue stream shows a higher variation (CV 0.34) than in other cases of royalty, but a lower variation as compared to income tax. The stream of the earnings of the mine, however, now has a greater variation (CV 6.45).

Presumptive Income Tax[30]

A cost of K 9,000 per kilogram of gold produced is assumed for the initial year. It is kept constant in real terms throughout the life of the mine by indexing it with the rate of inflation. A tax rate of 39% on presumptive income gives the same revenue as the base case. Government revenues are slightly less variable (CV 0.57) and the investor's earnings more variable (CV 5.49) as compared to a pure income tax.

Variable Presumptive Income tax[31]

Here the same assumption is made about the cost of production as in the case of presumptive income tax, but a variable rate of income tax is applied (33% for price of gold less than K 400, 44% for price more than K 400 but less than K 500, and 60% for price more than K 600 per troy ounce). While the

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[29] It is like an advalorem output tax, the only difference being that the rates vary with prices. This is an attempt to share the wind fall profits that the investor may be making during periods of high mineral prices.

[30] When sale prices are determined in the international currency while costs are in local currency which may be going up faster because of higher inflation, the costs are adjusted by a suitable index.

[31] Costs are again indexed and at the same time tax rates are varied depending upon the price of gold.

government revenue is slightly less variable, the investor's earnings in this case exhibit greater variability than both the pure and the presumptive income taxes. The variation is now due to changes in output and input prices as well as the variable rates of income tax.

Royalty and Income Tax

This is the same as the base case but with different rates. Here the royalty is given as 4.5% and the corporate tax rate as 22%. In this case, the income tax revenue has a coefficient of variation of 0.69, royalty a CV of 0.18 and total government revenue a CV of 0.49, while the investor's cash flow has a CV of 5.59. From the government's point of view, this combination of royalty and income tax causes a greater variability of revenues than the different options of royalty, but a lower variability than the various kinds of income taxes.

It is evident that while royalties alone or in combination with income tax produce a steady stream of government revenue, they yield a more variable stream of investors' earnings. With income taxes, the investors' cash flow is less variable but the government revenue exibits higher variability.

Progressive Profits Tax (PPT)[32]

A progressive profits tax of 40%, on income in excess of 10% of the accumulated capital investment, and a 20% income tax on the after-PPT-income yield the same revenue as the base case. The government revenue, however, exibits a very high variability (CV 0.78) in this case. The investor's earnings are more stable as compared to the other types of income taxes (CV 5.28).

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[32]This is similar to progressive individual income tax. Additional profits that raise total annual profit above a certain ratio to the value of the accumulated investment is taxed at a higher rates. For a discussion of Progressive Profits Tax, Resourse Rent Tax, and Brown's Tax, see Garnaut and Ross (1983).

Resource Rent Tax[33]

A resource rent tax alone of 67% gives the same revenue as the base case. The coefficient of variation of the government earnings is higher than even the PPT (CV 1.08). If used in combination with the income tax, the variability is reudced, but remains higher than the case of the income tax alone or the PPT. This tax also causes a large variability in the investor's cash flow (CV 7.83).

The resource rent tax has been acclaimed as having the significant advantage of capturing the wind fall profits without creating an atmosphere of uncertainty from the investor's point of view. It, however, suffers from this major shortcoming of creating a large variability both in government revenues and in the investor's cash flow.

Brown's Tax[34]

A pure cash flow tax of 83% is able to produce the same revenue as the base case. The variability of the government revenue in this case is, however, the highest among all the cases considered so far (CV 3.30). A combination of 50% of Brown's tax and 35% of income tax is again equivalent to the base case. The variability is reduced to some extent (CV 2.29) but it is still higher than all the other types of taxes. Thus the advantage of the tax being completely neutral is more than off set by the enhanced risk to the government.

The investor's cash flow is vary stable (CV 3.30 and 4.78) as compared to all the other cases.

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[33] This is an additional profits tax that is levied when a certain threshold internal rate of return has been realized.

[34] It is a pure cash flow tax and is completely neutral. If cash flow is negative in any year, the government is supposed to compensate the investor.

Table 18: Variability of Government Revenue and Inventor's Earnings

	Coefficient of Variation of Govt. Revenue	Coefficient of Variation of Investors' Cash Flow
(a) Unit Royalty on ore	0.08	6.22
(b) Unit Royalty output	0.24	5.92
(c) Ad Valorem Royalty	0.24	5.99
(d) Income Tax	0.64	5.42
(e) Royalty & Tax (base case)	0.57	5.92
(f) Royalty (5.6%) Tax (24%)	0.49	5.59
(g) Variable Royalty	0.34	6.45
(h) Presumptive Income Tax	0.57	5.49
(i) Var. Presumptive Inc. Tax	0.55	5.62
(j) Progressive Profits Tax	0.78	5.28
(k) Resource Rent Tax (RRT)	1.08	7.83
(l) RRT and Income Tax	0.85	7.06
(m) Brown's Tax (BT)	3.30	3.30
(n) BT plus Income Tax	2.29	4.78

3.3 Overvalued Exchange Rates

This is a policy instrument that has tax like effect on the investor. There has been a tendency for exchange rates to remain overvalued in most of the developing nations[35] and the Pacific island countries are no exception to this. Table 19 on page 41 presents a comparison of official exchange rates of currencies in Papua New Guinea, Solomon Islands, and Fiji with their effective and open market exchange rates[36]. As seen from the actual differences in the official/effective rate of exchange and its real value, there is an overvaluation ranging from 10 to 25 percent.

The effect of keeping an overvalued exchange rate is also analyzed for 'Misima' mine. Four alternatives are examined. The first one is that of a freely floating exchange rate. Suppose that all restrictions are removed and the local currency (Kina) is allowed to depreciate at a rate determined by the market conditions. Let the rate of depreciation be two percent per year over the life of the mine. Under these assumptions, the mine has a net present value of K 8.28 million, an internal rate of return of 10.55% and yields tax revenues of K 63.23 million and royalty payments of K 7.58 million.

In the alternative, suppose the government keeps a fixed exchange rate and adjusts it only after every two years for the effects of relative inflation. This means that on average the exchange rate is slightly overvalued. As a result, the net

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35 For details, see Gillis, Malcolm; Perkins, Dwight H.; Roemer, Michael; and Snodgrass, Donald R. "Economics of Development" (W.W. Norton and Company, New York, London, 1983).

36 These rates are from "1988 World Currency Yearbook" ed. Cowitt, Phillip P. (International Currency Analysis,Inc.; New york).

Table 19: Official, Effective, and Black Market Exchange Rates In Papua New Guinea, Solomon Islands, and Fiji

1. Papua New Guinea

	1983	1984	1985	1986	1987
Official Rate (US $/Kina)	1.309	1.309	1.309	1.309	1.309
Effective Rate	1.142	1.062	0.988	1.040	1.138
Black Market Rate	0.93	0.94	0.95	0.92	0.95

2. Fiji

Official Rate (US $/Fiji $)	1.250	1.250	1.250	1.250	1.250
Effective Rate	0.956	0.875	0.893	0.873	0.887
Black Market Rate	0.92	0.86	0.96	0.83	0.87

3. Solomon Islands

Official Rate (US $/Solomon $)	1.31	1.31	1.31	1.31	1.31
Effective Rate	0.82	0.74	0.62	0.50	0.52

The effective rate refers to the controlled floating exchange rate applicable to international transactions while the black market rate reflects the unofficial rate, which is generally a measure of the true or real worth of the currency.

present value falls to K 5.29 million. If the overvaluation is maintained for a longer period and the necessary adjustment is made after every three years, the net present value will drop further (K 2.97 million). In the last alternative, if the government adjusts the exchange rate after every three years but makes an over-adjustment of the rate in that year (i.e. the rate overshoots and for one year the currency is actually undervalued), the net present value of K 6.25 million is still lower than the case of the freely floating exchange rate. It is apparent that as a result of maintaining an over-valued exchange rate, the investor producing an export commodity loses. In all these cases tax revenue and royalty payment also decline, but only marginally.

2.5 Conclusion

Several interesting and significant results emerge from the cost benefit analysis of the data from the 'Misima' gold mine. The project is beneficial to the investor and also yields substantial amount of revenues in the form of income tax and royalty payments to the government. It also yields a high return to the economy. The government is the main beneficiary of the externalities generated by the project.

The project is particularly sensitive to the price of gold which is determined by forces in the international market. A risk analysis shows a positive, though small, expected value of the net present value of the project. This is mainly because of the way the parameters have been set up. While the output price has been assumed to move cyclically and take smaller values on the declining part of the cycle, the cost is not likely to go down significantly from its present level of K 9 per ton of ore.

No highgrading is observed up to fairly high rates of royalty. The net present value of the mine falls with higher rates of income tax and rising domestic inflation. A clear trade-off is seen between royalty payments and the income tax revenue. As royalties are increased, income tax collections fall but by smaller amounts. In the ranges discussed here, a higher royalty rate will bring greater overall revenues to the government so long as the enhanced royalty rates do not cause highgrading.

A higher debt equity ratio in financing of the project means a higher net present value to the investor and a lower income tax revenue to the government. The government of Papua New Guinea has kept 75 percent as the upper limit for debt which entitles the investor to claim a high interest deductibility from taxable income.

The results confirm the theory that the net present value of the mine will be maximized when the highest grade ore is mined in the period of highest discounted price and then a corresponding sequence of declining grades and discounted prices is followed.

An analysis of the impact of different tax regimes on the mine's cash flow shows that royalties alone, or in combination with income tax, produce a steady flow of government revenue, but they cause a greater variability in the stream of the investor's earnings. With the various types of income tax the position is reversed. Now the investor's cash flow becomes more steady while the variability of the government revenue is enhanced.

The situation gets worse with other types of taxation adopted by governments in their bid to share windfall profits. The Progressive Profits Tax increases the variability of the government revenue even more. The Resource Rent Tax, which has the advantage of capturing greater share of profits during periods of boom without contigent apprehension of an upward revision in tax rates applicable to the foreign investors, causes a substantial rise in the variablity of both the government and the investor's earnings. This outcome is slightly mitigated when Resource Rent Tax is applied in conjunction with an income tax. The Brown's Tax, which has the quality of being neutral, turns out to be a source of maximum variabilty in government revenue and least variabilty in investor's earnings as compared to all other forms of taxation.

Maintenance of an overvalued exchange rate by the host government results in a substantial reduction in the investor's earnings. This policy therefore creates a tax like disincentive and is likely to discourage foreign investment in the mining sector.

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