EXPORT INSTABILITY, INVESTMENT RISKS AND MINERAL TAXATION IN PAPUA NEW GUINEA

A thesis submitted for the degree of Doctor of Philosophy of the Australian National University.

By
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Declaration

Except where otherwise indicated

this thesis is my own work.

Samson M. Polume

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Abstract

The instability of export earnings is usually defined in terms of short-run fluctuations in export proceeds around a trend. Fluctuations in export earnings of primary commodities have long been a major cause of concern for many developing countries. Studies of export instability and its effects on growth and development vary in their findings; while some suggest that export instability is detrimental to growth and development, others draw the opposite conclusion.

In Papua New Guinea, there has been considerable concern with the fluctuations of export earnings originating in both the agricultural and mineral sectors. Since the mineral sector has become the single most important government and export revenue-earner, there has been a particular concern with fluctuations in international mineral prices.

Economic growth in Papua New Guinea since the early 1970s has been described as 'low'. Our empirical results suggest that in general export fluctuations have a negative effect on growth. In particular, the analysis shows that export earning instability has a negative effect on the growth of private expenditure, fixed capital formation (fixed investment), imports and total employment. These results confirm that fluctuating export earnings are an important factor in the relatively 'low' economic growth of Papua New Guinea.

When export earning instability is regressed against the growth of government expenditure, exports, savings and capital inflows, we find no negative effect. This suggests that some stabilisation mechanisms are at work. Given that government expenditure is subsidised by Australian aid, this result is not surprising. The heavy flows of investment to the mining sector especially during the period of analysis may also have offset the otherwise adverse effects of export fluctuations on savings and capital investment.

The concern of the governments of Papua New Guinea with the stability of public expenditures has led to the introduction of mineral resource taxation and to the establishment of the Mineral Resources Stabilisation Fund to absorb fluctuations in revenues from mining. Mineral resource taxation became an important source of revenue for the Papua New Guinea economy when the Bougainville mine came into production in 1972. It was the renegotiated Bougainville Copper Agreement (1974) that saw the emergence of a form of resource rent tax. Income from mining was especially set aside in
the Fund to provide a steady flow into the yearly budget. This was necessary given the fluctuating nature of mineral prices.

The empirical analysis focuses on government revenue sources and the way these are affected by export earnings instability. To the extent that revenue sources are affected by fluctuating export earnings, they are channels of transmission of export instability. In terms of tax revenues, the analysis shows that mineral revenues, via the Mineral Resources Stabilisation Fund flows, are an important channel of the transmission of export instability.

Papua New Guinea is likely to become even more highly dependent on mineral revenues in the future when new mines come into production. This points to the need for a better fiscal regime that will capture the rents in 'boom' periods to be used in 'bust' periods. Fluctuation in mineral revenues require a two-tier tax system to capture the benefits of mining to the host government without discouraging investment in the sector. The company tax, royalty and additional profits tax as presently in use in the mining sector in Papua New Guinea captures the benefits of mineral exploitation for the government, at the same time maintaining 'efficiency' and 'neutrality' conditions. It does, however, increase the amplitude of income swings to the government. The Mineral Resources Stabilisation Fund should therefore be used for stabilisation purposes.
Abbreviations

A$  Australian dollar
APT  Additional Profits Tax
ASEAN Association of South East Asian Nations
BCL  Bougainville Copper Limited
fob  free on board
GDP  Gross Domestic Product
GNP  Gross National Product
IBRD International Bank for Reconstruction and Development
IRR  Internal Rate of Return
K  Kina
MRSF  Mineral Resources Stabilisation Fund
NIDA National Investment and Development Authority
NDS  National Development Strategy
NPEP  National Public Expenditure Plan
NPO  National Planning Office
NPV  Net Present Value
NSO  National Statistical Office
RR  Rate of Return
RRT  Resource Rent Tax
TOT  Terms of Trade
UNCTAD United Nations Conference on Trade and Development
US$  United States dollar

Special Symbols used in Tables

Ag  Silver
Au  Gold
Cu  Copper
CV  Coefficient of variation
gms  grams
na  not available
ozs  ounces (1 oz = 31.1 gms)
p  provisional
-  not applicable
Std  Standard deviation
t  tonne
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CHAPTER 1
INTRODUCTION

1.1 Overview

The instability of export earnings is usually defined in terms of short run fluctuations in export proceeds around a trend. Fluctuations in export earnings of primary commodities have long been a major cause of concern for primary producing countries, particularly those with a heavy concentration of export products, because primary product prices are subject to wide fluctuations. The majority of countries still largely dependent on primary product exports are developing countries. Economic studies of export instability and its effects on growth and development vary in their findings. While some argue that export instability is detrimental to growth and development, others have concluded that this is not the case. Most instability studies have been based on cross-sectional analysis rather than on individual country time series. The present study, in contrast, explores the effects of export instability on an individual country.

Almost all developing countries initially experience a high degree of export instability because they are dependent on one or two commodity exports. Hence, it is often argued that developing countries have particular difficulty in dealing with instability because of the structure of their economies. The richer a country's natural resources the longer it is likely, in pursuit of its comparative advantage, to concentrate on the export of its primary products. Thus countries like Bolivia and Zambia have taken much longer to diversify their exports than resource poor countries such as Hong Kong and India. Some high income countries, including Australia and New Zealand are still highly dependent on primary products. In time, however, primary producers tend to diversify within agricultural and mineral exports and to extend their exports to secondary and tertiary products. Countries like Brazil and Colombia, for example, are much less dependent on primary products than they once were.
1.2 Objective of the Study

Papua New Guinea attained its independence at a very low level of development and with a particularly poor endowment of human capital. It is rich in natural resources, but its terrain makes it costly to develop them. The construction of infrastructure is generally very expensive. Growth has accordingly been very low by international standards [Goodman, et. al., 1985]. Initially the country was dependent on agricultural exports which were highly susceptible to fluctuating prices. The early 1970s saw the emergence of minerals as an important export and public revenue source; however, the prices of minerals also fluctuate a great deal. Because of the growing importance of minerals in government revenues, mineral taxation was introduced with the principal aims of stabilising government revenues and capturing mineral rents but at the same time accommodating investors' profitability objectives. The effects of the mineral taxation policies in Papua New Guinea have thus become an important policy issue. The concern of the governments of Papua New Guinea with the stability of public expenditures also led to the establishment of the Mineral Resources Stabilisation Fund (MRSF) to moderate fluctuations in revenues from mining.

Because the Papua New Guinea economy is small, it is inevitably also open. These characteristics make the forecasting of export earnings for public expenditure difficult. At a time when agricultural products were the main export earners, there was much concern with the effects of export instability. The emergence of the mining sector and its export earning capacity led to further concern since fluctuations in mineral prices are even more pronounced than in agricultural prices.

This study of Papua New Guinea focuses on the following principal questions:

1. In what ways has export instability affected growth and development in Papua New Guinea?

2. Which structural features of the Papua New Guinea economy make it difficult to deal with the impact of export instability?

3. What role does mineral resource taxation play in the Papua New Guinea economy? Can it mitigate export instability?

4. To what extent has the MRSF helped dampen the effects of export earning fluctuations?

Since the application of the additional profits tax (APT) in conjunction with the company tax in the mining sector in Papua New Guinea, there has been a debate about the policy implications of this resource tax. It focuses on the effects of the APT on foreign investment in mining. The original proponents of the APT [Garnaut and Clunies Ross, 1975] argue that it is a neutral tax; that is, it should not affect investment as it is a tax on super-normal profits. This study attempts to apply the APT on three projects to evaluate its impact on company and government finances.
1.3 Methodology and Approach

Deviation from trend of exports

Chapter 2 briefly discusses the various ways of measuring export instability. For the present study, the approach has been twofold: deviation from trend and coefficient of variation of export earnings.

The deviations from trend have been derived by regressing the natural logarithmic values of the relevant variables against time. The resulting fitted value for each observation is then converted to its numerical equivalent by taking the antilog of the logarithmic values. The deviation from trend is the actual (observed) value minus the fitted (predicted) value. If the trend deviation of the variables affects any of the other variables, then the variables must at least move in the same direction. This directional movement between, for example, exports and GDP, both measured as deviations around a trend, suggest that one affects the other. The extent to which one variable affects the other depends on the coefficients of the independent variable. The resulting t-ratio derived from the regression indicates the significance of this relationship. The deviation from the trend of exports in this context is derived as $\Delta X_t$. This measure has been used to evaluate the ways in which export fluctuations are transmitted to the domestic economy. That is, those variables (also measured as deviations around trends) which move in the same direction as the export trend, are the transmission mechanisms of export fluctuations.

Coefficient of variation of exports

Another method for the measurement of export instability employs a 5-year moving average of real exports over a 23-year time span (1961-1983). First, the nominal export values were deflated by using the GDP deflator supplemented by the consumer price index where the former is incomplete. The conversion was necessary to allow for inflation. These 5-year moving averages were lagged by two years so that the actual observations correspond to the middle years of the five years. Having derived the moving averages, the next step was to calculate the deviations from trend for each of the observations derived by subtracting the moving average of real exports from the actual exports values.

Since we are interested in finding the coefficient of variation of exports, the standard deviation of the moving average observations (19-year data) then had to be found. The coefficients of variation of export earnings for each of the 19-year data are derived by dividing the standard deviations by the mean exports. The coefficient of variation in this case is the measure of export earnings instability depicted as $E$. The coefficient of variation of exports in effect measures the 'risk' in export earnings due to market fluctuations, and this has been used to test the effects of export instability on other growth and development variables.
Investment risks and mineral taxation policies

Having determined the ways in which export instability is transmitted into the Papua New Guinea economy, and its effects on growth and development, the study then focuses on the mineral sector. In particular, we examine the mineral taxation policies as they currently operate in Papua New Guinea, and evaluate their impact on the Bougainville mining project and the proposed Misima and Porgera projects. The impact of taxation policies on mining projects affects investment decisions by investors; thus, the use of alternative taxation policies may provide some indications of this impact (if any) in Papua New Guinea.

Given the net present value (NPV) and cash flows of mining projects, it is possible to evaluate the investment risks to the government and companies using alternative taxation policy assumptions. The impact of taxation policies on the revenue generating capacity of the mines is another important issue to be considered. Incorporated in this analysis is the extent to which a mineral and its price fluctuations affect revenues in the economy.

1.4 Outline of the Study

Chapter 2 reviews export instability and its causes and effects on the development and growth of developing countries more generally. Most studies of export instability have concentrated on a cross-sectional approach. Individual country studies have only become evident recently. Individual country studies of some island economies in the South Pacific are reviewed to provide a perspective for the study of Papua New Guinea.

Chapter 3 presents the empirical results of the effects of export instability in Papua New Guinea. It begins by outlining the economic policy framework pursued before and after political independence in the country. The analysis suggests that Papua New Guinea suffers from export instability, and therefore its economic growth is hampered. However, this is not the only factor.

Since the study also focuses on mineral taxation, mineral policies of countries sharing similar resource endowments, in particular, in the Association of South East Asian Nations (ASEAN) region are examined in Chapter 4. These countries include Indonesia, Malaysia, Thailand and the Philippines. All have some form of mineral taxation policies that can be compared to policies in Papua New Guinea.

Chapter 5 provides the theoretical framework of the analysis of risk and uncertainty on investment decisions in general, and mining investment in particular. It also presents the definitional framework of various types of investment risks, and the interrelationships between investment risks and mineral taxation policies. The role of mineral taxation policies is spelt out, highlighting the differing objectives of the investor and host government.
Chapter 6 tests how export instability is transmitted into the Papua New Guinea economy. Identifying the transmission mechanisms is important for policy responses. Moreover, it provides the empirical framework for a comparative analysis of studies of similar countries. Evidence of the ways in which export instability is transmitted into the Papua New Guinea economy is presented. Various revenue sources, and in particular, mineral revenues, are important channels of transmission. This reinforces the concern of successive Papua New Guinea governments with fluctuating mineral revenues.

Chapter 7 provides the empirical analysis of investment risks within given mineral taxation policies of Papua New Guinea. It focuses on the effects of the APT on investment decisions. The chapter provides empirical evidence to questions about the effect of taxation on risk and investment. Given the differing objectives of investors and host governments with respect to mineral development, the chapter presents analysis of trade-offs between the two parties. The analysis focuses on an existing mine (Bougainville) and two projected investments (Misima and Porgera). The information used for the analysis, especially that about mine production capacity and the life of a project, is then used to quantify the trade-offs that the government and the mining companies would have to make to achieve their respective objectives. Different taxation scenarios are indicated to evaluate the efficiency or otherwise of these taxation policies.

Chapter 8 presents the conclusion of the study. It highlights the fact that a government must accommodate to the concerns of mining companies in attempting to devise tax and other policies so that continuing investment in mining is not jeopardised. For a country facing constant fluctuations in revenues, the study suggests that the MRSF is a worthwhile innovation and should bear the burden of stabilisation for the Papua New Guinea economy.
CHAPTER 2
EXPORT INSTABILITY IN DEVELOPING COUNTRIES: CAUSES AND EFFECTS

2.1 Introduction

Export instability is usually defined in terms of short-term fluctuations in export earnings of particular countries. Fluctuations in export earnings of primary commodities have been a major cause of concern for primary producing countries for some time. The majority of primary exporters are developing countries. A large number of studies of export instability and its effects on growth and development of developing countries have been done with varying conclusions. While some studies have found that export instability has a detrimental effect on the growth and development of developing countries, others have found no effect, or even a positive impact.

The studies of the nature of export instability and its effects on the growth and development of developing countries began with two a priori arguments that:

1. developing countries have experienced more instability in their exports than countries exporting industrial goods; and

2. developing countries have particular difficulties in dealing with instability because of the structure of their economies | Knudsen and Parnes, 1975: 2 |

As far as (1) is concerned, there seems to be agreement among economists that developing countries, particularly at early stages of development, have more instability than industrial and semi-industrial countries because developing countries tend to:

1. export mainly primary commodities;

2. concentrate on a narrow range of commodities; and

3. concentrate on a small group of traditional markets | Erb and Schiavo-Campo (1969); Naya (1973); Stein (1971); Lee (1977) |

The reasons for expecting fluctuations in exports to have a negative effect on growth and development of developing countries lie in the theoretical and practical relationships between export producers, entrepreneurs, investors and the public sector. Fluctuations in exports affect producers' incomes, create revenue fluctuations for governments and destabilise the balance of payments. Uncertainty about revenues affects
private and public investment, affecting production and savings. If trade is highly concentrated in a few agricultural or mineral exports, fluctuations in export earnings have a substantial effect on the economy. This is the basic reason for expecting that export instability will have some adverse consequences for the growth and development of developing countries specialising mostly in agricultural or mineral export products. The crucial question is whether or not individual country studies of export instability support this expected relationship.

2.2 Cross-sectional Studies of Export Instability

Table 2-1 summarises the conclusions of cross-sectional studies of export instability. These studies focused on the effects of export instability on economic growth and development through such economic variables as savings and investment. Output was generally measured as GDP or GNP.

Symbols and notations

Export instability can be measured by various methods, with each method leading to different results when testing for the effects on other variables [see Leith (1970); Stein (1971); and Moran (1983)]. There are also several methods of testing for the effects of export instability on growth (G) and development (D),\(^1\) ranging from simple regressions to multiple regressions involving many variables.

At least ten methods of deriving export instability indices, and four estimation methods for the determination of the effects of instability on other variables have been identified. Coppock (1962) was the first to measure export instability after World War II, establishing the Coppock index (CI). As further studies began to focus on export instability, other indices were devised. These include a standard error (SE), standard deviation (SD), standard deviation-corrected (SDC), standard deviation maximum likelihood (SDML), variance (V), least square (LS), annual average percentage change (APC), moving average (MA), and transitory income (TI) [see Appendix A].

Estimation methods

The estimation methods used to test the effects of export instability on other variables or vice versa have also varied, including simple linear regression (LR), multiple regression (MR), variance and covariance (V-C), and Spearman rank correlation (SRC). Most of the studies of export instability have been undertaken on a cross-section basis (CRA), with only a few time series for individual countries (ICA).

The studies undertaken to date can be grouped into three major categories:

---

\(^1\)Growth (G) refers to rate of growth of GDP or GNP, while development (D) is used as a general measure of trend deviations of the same variables.
<table>
<thead>
<tr>
<th>Author</th>
<th>Period</th>
<th>Country Type</th>
<th>Index Type</th>
<th>Method</th>
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<td>CI</td>
<td>MR, SRC, CSA, ICA</td>
<td>G(+), D(+)</td>
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</tr>
<tr>
<td>MacBean (1966)</td>
<td>1946-58</td>
<td>65 LDCs</td>
<td>CI</td>
<td>MR, SRC</td>
<td>G(+), D(+)</td>
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<td>18 DCs</td>
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<td></td>
<td>I(+)</td>
</tr>
<tr>
<td>Erb &amp; Schiavo-Campo</td>
<td>1946-58</td>
<td>50 LDCs</td>
<td>CI</td>
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<td>CSA</td>
<td>Y(n), S(-)</td>
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<td>SD</td>
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<td>1950-69</td>
<td>19 LDCs</td>
<td>SD</td>
<td>MR, CSA</td>
<td>CC(n), GC(-)</td>
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<td>Rangarajan &amp; Sunda-</td>
<td>1976</td>
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<td>11 LDCs, CI MR CSA I(-), Y(-)</td>
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</table>

Notes:
(a) For symbols used in the table see text: positive effect (+), negative effect (-), negligible effect (n).
(b) Index used for this study was to be found in another article but this could not be found. Stein (1977) argues the results are suspect for this reason.
(c) No references to the years covered in this study.
(d) Moran (1983) found different results for different time intervals: eg. G(-) for 1954-65, and G(n) for 1966-75. The author claims that for the period as a whole export instability "appears not to have a significant impact" [pp. 216-217].

Sources:
Derived from the references listed in text.
1. those showing that export instability has a positive (stimulating) effect on other variables such as savings, investment, growth and development;

2. those showing that export instability has a 'negligible' effect on these variables; and

3. those showing that export instability has a negative effect on the same variables.

**Export instability as a 'positive' factor in growth**

The first category includes Coppock (1962), MacBean (1966), Kenen and Voivodas (1972), Knudsen and Parnes (1975), Yotopoulos and Nugent (1975), and Lam (1980). All these studies show results contrary to the hypothesised expectation that the uncertainty associated with export instability would lower efficiency and the level of investment, and therefore adversely affect economic growth. In general the above studies support the hypothesis that a greater amount of uncertainty on export proceeds in developing countries induces risk averse individuals to save more, and therefore invest more, thereby exerting a positive influence on economic growth. See MacBean, 1966: 36; Kenen and Voivodas, 1972: 802; Knudsen and Parnes, 1976: 121-126; Yotopoulos and Nugent, 1976: 336-338.

**Export instability as a 'negligible' factor in growth**

Glezakos (1973) was the first to dispute the results derived by MacBean (1966) and Coppock (1962). Since then other studies have added to Glezakos' findings. These include Lancieri (1974), Rangarajan and Sundararajan (1976), and Moran (1983). These studies indicate that the adverse effects of export instability operate as follows: instability affects the export producer's income, creates uncertainty for government planners and entrepreneurs in investment decisions, and leads to discontinuous flows of imports of intermediate and capital goods.

Erb and Schiavo-Campo (1969), Massell (1970), Lim (1980) and Moran (1983) all found that export instability is a negligible factor in the growth of income in developing countries. But evidence of negative effect of export instability on the income of developing countries was found by Glezakos (1973) and Rangarajan and Sundararajan (1976).

**Export instability, savings and investment**

Some studies focus on savings (S) and investment (I). Lim (1980), and Knudsen and Parnes (1975) found that export instability has a positive effect on savings. Moran (1983), however, found that for one period export instability had a negligible effect on savings, while in another period it has a negative effect.

MacBean (1966) is known to have found that export instability has a positive effect on the rate of growth of investment. Contrary to their results for growth and development variables, Kenen and Voivodas (1972) found evidence of a negative effect of
export instability on investment. Lancieri (1978), Rangarajan and Sundararajan (1976), and Moran (1983) all agreed with this finding.

Causes of export instability

Variables thought to affect instability include commodity concentration (CC), geographic concentration (GC), specialisation in agricultural products (SA), economic size (SI), intra-regional trade (IT), and growth rate of exports (X).

MacBean (1966) found that geographic concentration, measured by using a Gini-Hirschman index, has a negative effect on export instability, suggesting that the higher the geographic concentration (the fewer export markets), the greater the degree of export instability. In another study Love (1979) supported this finding with both geographic and commodity concentration indices. Naya (1973) lent support by finding a negative relationship originating from geographic concentration. Naya also found that commodity concentration and specialisation in agriculture do not affect export instability significantly; he found, however, that intra-regional trade increased the degree of export instability. In contrast to Naya, Massell’s (1970) study found that commodity specialisation in agricultural products reduced export instability and that geographical concentration of exports was a negligible factor [see Appendix B for the derivation of indices].

The cross-sectional results are thus inconclusive with regard to the effects of export instability on savings, investment and growth. Inconclusiveness could result from the lack of precision in the three variables as well as from inconsistent measurements of export instability.

2.3 Individual Country Studies of Export Instability

Malaysia

Lim’s (1972) time series study of West Malaysia (i) examines the reasons for and the extent of export instability; and (ii) tests the hypothesis that instability has been detrimental to economic growth during 1947-1968. In the early 1970s, West Malaysia was highly specialised in the production of tin and rubber, and fluctuations in the earnings of these commodities resulted in a "fairly high degree of economic instability". The foreign trade multiplier was less than one, leading to the implication that "the transmission of instability from the export sector to the rest of the economy was smaller than was commonly believed". Using simple regression analysis, Lim found "no correlation between annual percentage changes in real GDP and percentage deviations of export earnings from trend over the period, 1947-1968. However, in view of the nature of the problem and limited GDP time series, this really proved little concerning the effects of instability on growth" [Lim, 1972: 112].
In another study of Malaysia, Lee (1977) attempted to find whether or not Malaysia's specialisation in tin and rubber led to a high degree of export instability. His argument was "that specialisation in production and export of primary commodities generally implies a higher degree of export instability than specialisation in manufactures since primary commodities tend to be characterised by low price elasticities of demand and supply, and by uncontrolled variability in demand, in supply, or both". Lee found "the hypothesised relationship between export instability and specialisation in the production and export of raw materials (primary commodities)", and suggested that diversification away from raw material exports "may produce greater stability in export earnings" [Lee, 1977: 322-327].

Lee found that the export of natural rubber in the absence of an international agreement contributed to greater export instability in Peninsular Malaysia than tin exports which were made under an international buffer stock-cum-export restriction scheme. The study also concluded that export instability was also dependent on the characteristics of export markets for commodity exports and a nation's concentration in a few commodities [see Lee, 1977: 330].

Brazil

Adams and others (1979) identified export instability linkages to the domestic economy in Brazil, an important coffee producer with influence on the world coffee market.

(1) Production-income linkages. This linkage is seen where fluctuations in coffee output directly affect the GDP, disposable income, and the corresponding flows of wage and non-wage income.

(2) Production-employment and input linkages. This is seen in cases where additional coffee production raises demand for labour and inputs from other productive sectors of the economy.

(3) Balance of payments effects. This effect results from movements in the value of coffee exports principally resulting from changes in volume exported or international prices, and this significantly affects the balance of payments and, therefore the ability to import.

(4) Tax revenue effects. The imposition of taxes on coffee exports and their impact on the Coffee Fund revenues is important as this directly affects government revenue and public spending.

(5) Monetary effects. This effect occurs through the impact of coffee earnings on foreign exchange receipts and the net balance of the Coffee Fund operations.

(6) Consumption effects. The consumption demand effects originate in the flow of private and public revenue.
(7) Investment effects. Coffee activity affects the level of aggregate investment by various channels. Government revenue flows into government investment expenditure. Foreign exchange earnings allow increase in imports of capital goods and impact on investment. The growth of GDP calls for a higher level of investment spending.

(8) Wage and price effects. In a country such as Brazil, wages play a role since the commodity producing sector could be a leading sector in the process of wage determination. In some developing countries, high wages paid in some primary producing sectors have contributed to an upward bias in other sectors.

From this study, Adams and colleagues concluded that "fluctuations in the coffee market have magnified the impacts on the macro variables of the Brazilian economy. Increases in coffee output and/or in the value of coffee exports translate into a higher real product with effects on income, government revenues, secondary and tertiary sector activity, investment, foreign exchange earnings, etc. Prices are also affected" [Adams, et al., 1979: 168].

Colombia

Mayer (1982) used a computable general equilibrium model to study the implications of export instability on economic growth in Colombia. This approach helps to trace the transmission of export instability to the macroeconomic environment of the Colombian economy. The model is constructed around an input-output system of accounts and emphasizes the role of prices and substitution prospects in explaining trade flows and the composition of domestic economic activities. The model has six industries producing six commodities (coffee, other agriculture, mining, food processing and consumer goods, raw materials processing, and investment goods and services). The demand side contains intermediate, export, consumption, government and investment goods. The model consists of an interdependent system of equations: the solution requires a simultaneous equations solution algorithm.²

Mayer (1982, p. 755) simulated "the effects of a hypothetical 10 percent increase in export instability (which leads to an equal increase in instability in household incomes, coffee producers' revenues and the trade balance) on the level and composition of economic activity in Colombia." He concludes:

... that export instability is detrimental to economic development in Colombia. On the one hand, higher instability associated with export instability leads to higher savings. On the other hand, the government demands more international reserves in order to exert some influence in the presence of large transitory exogenous shocks. It turns out that the government's reserve demand

²The brief discussion here refers to the essential features of the model relevant to this study. For a more detailed explanation of the model see Mayer (1982).
exceeds the amount of resources provided by the 'voluntary' savings of consumers in view of unstable incomes such that real aggregate investment has declined considerably. This has negative consequences for welfare and in the longer run also for economic growth in Colombia [Mayer, 1982: 759].

2.4 Export Instability in Some Pacific Island Economies

Smallness generally means a narrow range of production and limitation on the range of primary production. It also implies wide fluctuations in both subsistence and export production because the effects of 'weather' are not equalised among a country's regions. Natural hazards such as hurricanes and cyclones add to the vulnerability of small Pacific islands. There is a relatively low volume of output because of the smallness of land area and this subsequently implies high unit costs for transport and marketing, and where it is necessary, processing.

Smallness has also resulted in very high concentration of exports in particular overseas markets. Export categories are relatively few and the total volume of exports is low. The smallness of the island economies makes them price-takers and therefore their domestic market conditions are subject to fluctuations and instabilities, especially in their export products.

The implications of export instability

The impact of export earnings instability on economic growth and other variables, especially for developing countries, is inconclusive. There now seems to be some agreement that the appropriate approach to finding how export instability affects growth, savings and other variables is to study individual countries. Attention to this approach has only been given recently and results to date are generally not any better than the cross-sectional studies. Of the studies concentrating on the effects of export instability, three were specifically directed to Fiji, Western Samoa, and the Cook Islands in the South Pacific. All these studies paid particular attention to the domestic and international trade structures of these island economies and how they are affected by fluctuations in export earnings.

Western Samoa

In a study detailing the effects of export instability on economic growth and development for Western Samoa, Altman (1978) sets out to find answers to two principal questions: (1) what are the short-term or annual consequences of export instability? (i.e. does export instability cause economic instability? (2) Does export instability deter longer run economic growth and development? With regard to Western Samoa, Altman suggests that the "link between export instability in the export sector and the rest of the economy depends on the size of the foreign trade multiplier, the "openness" of the economy, and the indirect effects of export instability [Altman, 1978: 36].
Altman identified five main arguments for expecting export instability to have, directly or indirectly, a negative effect on the economic growth of particular countries.

(1) Inflation argument - suggests that export instability is a cause of inflation originating from high wages and incomes in the export sector during periods of export boom. It is also sometimes argued that during periods of export boom, there is a tendency for governments and firms in developing countries to increase expenditure, especially on imported goods and services. When the export boom comes to an end, there is usually a shortage of foreign exchange reserves, and this may lead to the government imposing import controls on consumer goods imports, and may therefore result in domestic bottlenecks and inflation. The overall reasoning of the argument is that the rising price level will be detrimental to investment and business confidence, and hence to economic growth.

(2) Trade and growth argument - this emphasises the possibility that export instability may cause allocation inefficiency especially in low income countries where farmers may be tempted to switch to the production of crops that yield stable annual income rather than crops which yield the higher return in the long run. In such cases, export growth will be retarded, leading to limited achievements of economic goals, and therefore acting as a 'brake' on growth and development.

(3) Opportunity cost argument - this suggests that export instability has some opportunity costs associated with it. For many developing countries where skilled manpower is scarce, diversion of scarce personnel from the immediate tasks of development planning to deal with balance of payments problems may in the longer run lead to slower growth and development.

(4) Development and planning argument - this suggests that export instability interferes in the implementation of development plans. It is argued that fluctuations in export earnings will lead to fluctuations in foreign exchange availability, and where the country relies on imported capital goods for development purposes, this may deter economic growth and development.

(5) Economic instability and growth argument - this emphasizes the notion that export instability causes economic instability, and this in turn leads to the assumption that economic growth in the longer run will be hampered.

Altman's regression analysis did not support these hypotheses. He had to conclude that:

...the Western Samoa economy revealed that because of a number of factors the extreme instability in the export sector was not transmitted to the rest of the economy, and the only conclusive argument against export instability was the trade and growth argument. Here, the major factors for the otherwise insufficient transmission of export instability into the domestic economy is
because the Samoan agricultural producers have the alternative of relying on subsistence agriculture for sustaining consumption levels while export instability acts as a disincentive for cash cropping... Western Samoa acts as a good counter example - a situation where export instability does have negative consequences one may envisage on purely theoretical a priori grounds. Other case studies may reveal other anomalies about economies that a cross-sectional approach may overlook. Hence one must conclude that to adequately analyse the consequences of export instability on an economy it may be more fruitful to utilise the case study approach rather than the cross-sectional approach” [Altman, 1978: 41].

The Cook Islands

Fairbarn (1984) studied instability in the Cook Islands. Two principal causes of export instability were identified; namely, “the highly fluctuating nature of export earnings on the one hand and exposure to chronic imported inflation arising from a heavy import dependency on the other” [Fairbarn, 1984: 57]. With an estimated population of 16,900 in 1982 and a total land area of 240 sq. kms, the options for development for the Cook Islands are limited. The population and physical size are very small, the islands are geographically fragmented, there are few natural resources, and transport costs are high. There is shortage of development capital and skills due to high emigration rates.

Citrus juice, copra and bananas are the three major exports from the Cook Islands, and New Zealand is the sole market. There is therefore a high degree of commodity and geographic concentration. Fairbarn notes that this high degree of concentration is “exceptional and is perpetrated by such factors as free entry to the New Zealand market and present shipping and air services arrangements” [Fairbarn, 1984: 59]. In terms of imports, food items constitute a major component of the import bill so that fluctuations in export earnings could mean fluctuating consumption levels.

Aid is, however, a stabilizing influence and so are remittances from emigrants. Fairbarn noted that “export earnings as a proportion of GDP in 1978 were a modest 14.7 percent”, hence, “the impact of export instability on the domestic economy has been less sharp than for many other developing countries. Far more important factors in determining the level of economic activity and with it the degree of fluctuation, have been the amount of foreign aid received, particularly from New Zealand.” Another equally important reason is “the fact that prices the Cook Islands received for certain major exports are fixed by negotiation rather than world market forces” [Fairbarn, 1984: 63].

Given the modest size of the export sector in the overall economy of the Cook Islands, and the absence of export taxes, export fluctuations do not have a considerable impact on government revenue. The assurance of foreign aid and remittances, and the substantial role played by the subsistence sector in meeting food and shelter has played down the concern over the effects of export instability by the Cook Islands government. Given these circumstances, the country has learnt “to live with a certain amount of export instability and the consequences therefrom” [Fairbarn, 1984: 66].
Fiji

The most comprehensive study of export instability in an island economy is Knapman and Schiavo-Campo's analysis of the Fiji economy. The study, moreover, covers 103 years. It attempts to account for a lengthy and significant segment of Fijian economic history.

With an estimated population of 650,000 and GNP of SUS 1.2 billion in 1982, Fiji is relatively well-off in per capita terms. Fiji's major exports are sugar, copra and coconut products, gold, and tourism.

The 103-year span is subdivided into 8 subperiods to reflect "an examination of the major events in the country's economic history, as well as consideration of the nature of the actual data" [Knapman and Schiavo-Campo, 1984: 99].

(1) Gradual Transformation (1875-1906). This early period was "characterised by steady if unspectacular increases in exports accompanied by fairly sharp fluctuations around the trend" [Knapman and Schiavo-Campo, 1984: 105]. During this period planters shifted from the production of cotton to sugarcane and copra making use of imported labour that became available around 1879. The subsequent growth of sugar exports was fostered by duty-free treatment of sugar imports into Britain from 1874 to 1901, but hampered by increasing production and competition from beet sugar in Europe.

(2) Colonial Golden Age (1906-1915). This was a period of high growth and relatively mild export fluctuations. The mild fluctuations were a result of the earlier expansion especially in the sugar industry.

(3) Swing Era (1915-1934). This period exhibited by far the greatest degree of export fluctuations of the eight periods considered, resulting from both external and domestic upheavals; merchandise export earnings were lower at the end than at the beginning of the period.

(4) Recovery (1934-1939). This period saw a remarkably smooth and speedy recovery of Fiji's exports. From 1932 onwards gold became Fiji's second major export, earning twice as much as copra and copra products and almost half as much as sugar exports from 1936 to 1940.

(5) World War II (1939-1945). The experience of the early part of the 'Swing Era' of 1915 to 1934 was repeated. Though sugar exports fell due to a labourers' strike in 1943, this was offset by increased gold earnings, thus maintaining steady growth in exports.

(6) Late Colonial Instability (1945-1966). This period was similar to that of the early period of 1875-1906 in which there was steady though unspectacular export growth. But instability associated with fluctuations in the world prices of primary commodities was greater than in the earlier period.
(7) Transition to Independence (1966-1973). Fiji became autonomous with regard to internal affairs in September 1967 and totally independent in October 1970. These years were marked by a slight acceleration of export growth from the modest performance of the previous 20 years, and by a marked decrease in short-term instability. Export fluctuations in 1966-1973 were the second lowest of the periods considered, reflecting the stability of sugar export earnings, arising from fixed contracts, during that time.

(8) Early Independence (1973-1978). This period was characterised by rapid growth and high export earning instability. Two of Fiji's main exports, sugar and gold experienced increased prices during this period, thus maintaining some degree of economic growth. The exports of services, especially tourism, made a significant contribution to the overall stability of Fiji's external trade.

Knapman and Schiavo-Campo concluded that "Fiji over the longer term has experienced export fluctuations relatively no greater, and in all likelihood lower, than many other former colonial territories" (Knapman and Schiavo-Campo, 1984: 112).

Using a linear trend method to measure export instability and growth, and defining the export instability index as the standard error of the function \( Y = a + bX \) (where \( Y \) is exports and \( X \) is years), normalised by dividing by the mean exports of the subperiod, the authors proceeded to determine the effects of export instability on the Fijian economy. From this they concluded there is:

... no evidence of an association between export instability and growth. The correlation between \( g \) (growth) and \( I \) (export instability) (whether linear or rank correlation) in our subperiods is very low and statistically insignificant. There is, therefore, no basis whatever either to presume that export instability necessarily retards growth for less developed countries in general or to conclude that it has done so in the specific case of Fiji over the last hundred years (Knapman and Schiavo-Campo, 1984: 112).

2.5 Conclusion

The cross-sectional approach to studying the effects of export instability suffers from assuming that similar economic and institutional factors affect exports of developing countries. Evidence from individual country studies, even those with similar economic environments, appears to contradict this assumption and therefore makes the cross-sectional approach of doubtful utility.

Some empirical studies support the a priori reasoning that developing countries that are still exporters of primary commodities are adversely affected by the instability of primary product prices. But most studies of export instability and its effects on the growth and development of developing countries are inconclusive. This could be for the following reasons:
1. inconsistency in measuring export instability;

2. imprecise measurement of growth and development (using GDP or GNP);

3. sample problems regarding coverage of time interval; and

4. lack of differentiation among developing countries according to their domestic structures; see Yotopoulos and Nugent, 1976: 330-331; Lim, 1976: 312; and UNCTAD, 1984: 10.

The first reason has attracted a lot of debate, and as noted earlier, there are at least ten different ways of measuring export instability. Thus, it has been found that different export instability indices lead to varying results and conclusions about the effects of export instability.

The second reason has more to do with the question of whether to use GDP or GNP growth as a measure of economic growth. In general, however, the question of using one or the other depends on the availability and reliability of time series data for a particular variable. In most developing countries, time series of GNP may not be reliable because factor payments accruing abroad (which are included in GDP but excluded from GNP) are often not adequately accounted for in the national accounts.

The third and fourth reasons give little consideration to the different historical and economic structures of the countries studied. The fourth is a more serious problem especially to do with cross-sectional studies where countries are clustered together without much concern for their domestic and international economic structures or policies.

Cross-sectional studies which support the view that most developing countries are adversely affected by export instability make little attempt to find out the mechanisms that lead to negative effects. A more direct approach would be to study the effects of export instability on any one country with due regard for its domestic structures and international economic relations.

South Pacific island countries

The studies of three South Pacific island economies highlight the differing degree to which particular countries can be affected by export instability. Different economies are affected differently by fluctuating export earnings; a cross-sectional approach does not necessarily account for these different effects.

The degree to which island economies are affected depends very much on the domestic policy framework dealing with the fluctuating nature of their export earnings. The channels through which export instability is transmitted into the domestic economy are also not necessarily the same; this is why different effects are experienced. It follows therefore that the appropriate policy approach to counteracting the effects of export
instability may have to be different for different countries, depending on the transmission mechanism and the overall economic structure of the countries.
CHAPTER 3
DEVELOPMENT PATTERNS AND EXPORT INSTABILITY IN PAPUA NEW GUINEA

3.1 Introduction

The early years of Papua New Guinea’s development were characterised by a lack of development objectives. At the time of self-government and independence, the 'Eight Aims' became the major framework for economic policy-making. These objectives reflected the new nation’s social aspirations but they failed to emphasise that economic growth was needed to achieve social equity. Thus, it was only some ten years after the 'Eight Aims' were adopted that it began to be noted that economic growth in Papua New Guinea was relatively low in comparison to many other developing countries, notably those in Southeast Asia.

Prior to the adoption of the 'Eight Aims' in 1973, little or no coherent development philosophy was evident as the country began to loosen the grip of colonialism on the economy. Australia had made very limited efforts to prepare the country for political and economic independence. Papua New Guinea thus achieved nationhood on September 16, 1975\(^1\) poorly equipped in terms of human capital and with an enormous development task ahead of it. Ten years after the achievement of political independence, the scale of this task is still evident in inadequate education and other infrastructural facilities, slow growth of agriculture, inadequate employment growth and consequent social problems.

In this chapter some of the factors that have led to relatively low economic growth are identified in the context of the principal characteristics of the Papua New Guinea economy. More importantly for the purpose of this study, the relationship between export instability and economic growth is examined.

\(^1\)There was a two-year period of self-government from mid-1973 to September 1975.
3.2 Policy Framework and Objectives for Development

3.2.1 The Early Years of Development

In contrast to other countries in the region, the Territory of Papua and New Guinea lacked a coherent development program in the late fifties and early sixties. The Territory had been ruled by three successive colonial powers: Germany (New Guinea), the United Kingdom (Papua) with Australia finally coming to administer the two territories as one with New Guinea remaining under the League of Nations as a trust territory. In the mid-1960s Australia began to make an effort to adopt a development orientation. At Australia's request a team from the International Bank for Reconstruction and Development (IBRD), headed by I.K. Iverson, set out to "undertake a general review of the economic potentialities of the Territory and to make recommendations to assist the Australian Government in planning a development program designed to expand and stimulate the economy and thereby raise the standard of living of the people" [Iverson, 1964: (iii)].

The Iverson Report led to a program for economic development with major emphasis given to the "stimulation of production and the advancement of the indigenous people" [Iverson, 1964: 27]. Within this broad framework of development, three major principles were identified:

1. Maximum economic benefit - which called for the concentration of effort to obtain the maximum benefit from development by concentrating in areas and activities where the prospective return is highest.

2. Standards - that services and facilities should be related to Territory conditions so that the maximum numbers of people would benefit from the money spent on the program, and this also applied to wage and salary levels so that financial viability would be achieved.

3. Fostering responsibility - this called for ways of giving the people of the Territory some control over the administration of their welfare and other essential services [Iverson, 1964: 30-32].

This was the first major attempt by Australia to bring in independent experts to assess the economic conditions of the then Territory of Papua and New Guinea and recommend policies to develop it.

3.2.2 Development for Nationhood

The Faber Report

Just prior to self government in 1973, a major study was undertaken by the Overseas Development Group (University of East Anglia) at the request of the United Nations Development Program. The IBRD was the implementing agency, choosing a four

1. Increased local, indigenous control of the economy, and indigenisation of many forms of economic activity: this may be regarded as one aspect of increasing national self-reliance.

2. Major increases in the opportunities for employment and, more particularly, for income-generating self-employment.

3. An emphasis upon the growth of income to nationals while at the same time avoiding gross disparities in local income distribution.

4. A comparatively greater emphasis upon rural development, upon a food and agriculture program, and upon the development of smaller urban centres in the countryside.

5. Adaptation of the economy so that it may become, after Independence, progressively less dependent upon foreign grant-in-aid and, ultimately, upon foreign investment capital; this may be regarded as a second aspect of increasing self-reliance [Faber, et. al., 1973: 4].

These objectives formed the basis of the National Development Strategy pursued by Papua New Guinea to independence and thereafter. The strategy was generally perceived as the policy response to Papua New Guinea’s 'Eight Aims'.

The 'Eight Aims'

The 'Eight Aims', announced by the then Chief Minister of Papua New Guinea (Mr. M.T. Somare) in December 1972, at about the time when the draft Faber Report was being discussed, provided the broad objectives for development:

1. A rapid increase in the proportion of the economy under the control of Papua New Guinean individuals and groups, and in the proportion of personal and property income that goes to Papua New Guineans.

2. More equal distribution of economic benefits, including movement towards equalisation of incomes among people and toward equalisation of services among different areas of the country.

3. Decentralisation of economic activity, planning and government spending, with emphasis on agricultural development, village industry, better internal trade, and more spending channelled through local and area bodies.

4. An emphasis on small-scale artisan, service and business activity, relying where possible on typically Papua New Guinean forms of organisation.

5. A more self-reliant economy, less dependent for its needs on imported goods and services and better able to meet the needs of its people through local production.

The other members of the team were Dr. A.M.M. McFurquhar (University of Cambridge), Dr. J.K. Hart (University of Manchester) and J.D. Diddens (University of East Anglia).
6. An increasing capacity for meeting government spending needs from locally raised revenue.

7. A rapid increase in the active and equal participation of women in all types of economic and social activity.

8. Government control and involvement in those sectors of the economy where control is necessary to assure the desired kind of development [Papua New Guinea Government, 1974b: 1].

The 'Eight Aims' were an elaboration of the Faber Report. For example, participation by women in the economy was not an explicit part of the original recommendations. The 'Eight Aims' continued to be elaborated into more explicit objectives for social, political and economic development.

Why the 'Eight Aims'?

The leaders who were preparing the country for independence saw that Papua New Guineans had little control over their economy. Almost all major coffee, coconut and cocoa plantations were either owned by missions or by foreign businessmen. Few, if any, Papua New Guineans, were involved in major business enterprises. The new leaders argued that instead of having the domestic economy run by foreigners, with profits repatriated overseas, the involvement of nationals would retain a share of profits within the economy.

More importantly the first goal of the Eight Aims reflected the political and social aims of having nationals as decision-makers and planners. Successive Papua New Guinean governments have frequently been criticised for allowing foreigners to be policy-makers because the interests of foreigners are not always in harmony with those of the country.

The second goal of equal distribution of economic benefits reflected the serious inequalities, not only between nationals and non-nationals, but also amongst the nationals themselves. It was not confined to salaries and wages, but involved access to education and other social services. It also reflected regional inequalities, which if not checked, could create serious problem for a country of such tribal diversity as Papua New Guinea. It was politically important to counteract animosity between the tribal or regional groups.

The third goal of decentralizing government activities received the greatest attention in implementation. From its inception the Papua New Guinea Government began to establish provincial governments for its nineteen provinces (previously called districts). The objective was to have local participation in decision-making. However, this policy has led to high direct and indirect government costs.

The fourth goal which emphasized the Papua New Guinean way of doing things,
reflected the importance of retaining Papua New Guinean traditional values. Traditional values differed from tribe to tribe, but an overall sharing within the community rather than individual ownership prevailed. Whether such traditional values are consistent with day to day operation of a modern economy is an open issue.

The fifth goal advocated that Papua New Guinea should not be 'too' dependent on imports. It called for economic 'self-reliance' and 'living within one's means'. While this goal has its focus on imports, it also applied to the domestic sectors. For instance, many self-help projects in the rural areas of Papua New Guinea have had the support of the Government only after the community had some input into the initial stage of the projects. The Papua New Guinea governments often reiterated that self-reliance must begin at home.

The sixth goal advocated the need for an increasing capacity to raise revenue locally. It reflects growing concern of Papua New Guinean leaders, who wished to see revenue coming from within the country rather than from foreign sources, especially from Australia.

The seventh goal calls for equal participation of Papua New Guinean women in the country's development. Women do a high proportion of work and have a significant role in the traditional societies, but modern society has largely neglected women's participation.

Finally, the eighth national goal advocates government control in as wide a sphere of economic development as possible. This goal reflects a belief that the Papua New Guinea government has to assess, plan and initiate activities for economic, political and social development.

Deriving from the philosophy of the 'Eight Aims', a set of goals is enshrined in the constitution to reflect the concept that development must encompass all spheres of human development, not only economic development. These are known as the 'national goals and directive principles' and are spelt out under the following headings:

1. Integral human development.
2. Equality and participation.
4. Natural resources and environment.
5. Papua New Guinean ways.
3.2.3 Development and Growth: Ten Years After

It is in the context of the 'Eight Aims' that Papua New Guinea attempted to develop its social, political and economic institutions. Sectoral policies are expected to fall into the framework of these broad objectives. The Faber Report emphasized the need for agricultural development, but almost ignored mineral development, though Bougainville Copper Ltd. was formed in the late 1960s and began mining in the early 1970s. Following the establishment of the National Investment and Development Authority (NIDA), some broad objectives for industrial development were spelt out in 1975, but with very little active follow-up in the subsequent years [NIDA, 1975]. However, in late 1983 and early 1984, a more concerted effort was directed towards industrial development with the establishment of a separate department having as its first task the spelling out of long term policies in a White Paper on industrial development.

The main criticism of the Faber Report, which only became vocal in the early 1980s, was its neglect of economic growth objectives. The Report and the 'Eight Aims' assumed that growth would automatically follow equal distribution, self-reliance and government control. But this was not the case. Goodman, Lepani and Morawetz noted that "(if) growth in real GDP per head is taken as the measure of economic growth, Papua New Guinea's performance since Independence has been disappointing" [Goodman, et. al., 1985: 34]. The rate of growth of GDP for Papua New Guinea over the years 1976 to 1983 was estimated to be 1.4 percent per annum. This is very low in comparison to the average growth for developing countries. Economic growth as an objective has only recently been actively pursued by the Papua New Guinea government.

"The two goals that have received greatest emphasis in the last year or two are:

1. Growth in output per head and in average standards of living; and

2. Growth in productive employment opportunities to ensure that the rapidly increasing numbers of youths and young adults are able to find jobs" [Goodman, et. al., 1985: 33].

3.3 Papua New Guinea as a Small, Open Economy

Papua New Guinea is a small open economy, although it is large in comparison to the other island economies of the South Pacific. Shand (1980) did not include Papua New Guinea as a small economy in the categorization of Indian and Pacific Ocean states when population, land area, and GDP were used as measures [see Shand, 1980: 14, Table 2], but a population of 5 million is generally taken as a cut-off for small countries [see Jalan (1982)]. In economic terms in any case Papua New Guinea must be considered a small economy.

Problems of trade, growth and development faced by small, open economies have
been studied by a number of authors including, Robinson (1960), Demas (1965), Benedict (1967), Lloyd (1968), Selwyn (1980), Shand (1980) and Jalan (1982). The main characteristics of small economies can be summarised as follows:

(a) high dependence on international trade;
(b) high commodity and geographic concentration of trade;
(c) exposure to fluctuations in commodity trade and capital flows;
(d) lack of diversity of resource base;
(e) heavy dependence on external institutions;
(f) diseconomies of small economies;
(g) high transport costs; and
(h) small domestic market.

The Papua New Guinea economy possesses all these characteristics. Some 40 to 50 percent of Papua New Guinea's GDP is derived from exports. Papua New Guinea's trade structure is concentrated and exposed to fluctuations. Papua New Guinea is relatively well endowed with a variety of resources, but there is a lack of skilled human resources and capital. Papua New Guinea relies on Australia to finance about 30 percent of its government budget. With low per capita income and small population, Papua New Guinea's domestic market is very small, internal and external costs are high.

Geographical features divide the country into four or more very small sub-markets. According to Hughes the characteristics of small economies impose a number of constraints:

1. limited opportunities for import substitution,
2. limited opportunities for exploiting internal and external economies of scale in production, and
3. narrow choice of techniques for development purposes [see Hughes, 1984a: 2-4].

The Jackson Report also makes reference to these constraints and the difficulties they would impose for development in Papua New Guinea [see Jackson, 1984: 148-149]. On the other hand, there is the view that the "very limitations that smallness imposes have offsetting advantages in policy formation and implementation", and if properly exploited, can lead to successful growth and development [Hughes, 1984a: 4].
Table 3-1: Papua New Guinea: Domestic Export Earnings and Ratio to GDP, 1974-1984.

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<td>(K million, current f.o.b. prices)</td>
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<tr>
<td>Cocoa</td>
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<td>28.1</td>
<td>39.1</td>
<td>86.3</td>
<td>63.0</td>
<td>60.8</td>
<td>46.5</td>
<td>34.1</td>
<td>31.8</td>
<td>41.4</td>
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<td>100.2</td>
<td>143.4</td>
<td>107.3</td>
<td>125.0</td>
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<td>74.2</td>
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<td>25.0</td>
<td>20.3</td>
<td>35.6</td>
<td>35.4</td>
<td>58.6</td>
<td>25.0</td>
<td>41.2</td>
<td>32.0</td>
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<td>Palm oil</td>
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<td>6.4</td>
<td>6.8</td>
<td>8.6</td>
<td>10.5</td>
<td>14.4</td>
<td>11.9</td>
<td>14.2</td>
<td>21.7</td>
<td>23.7</td>
<td>75.8</td>
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<td>Tea</td>
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<td>4.1</td>
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<td>9.8</td>
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<td>8.0</td>
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<td>Rubber</td>
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<td>13.6</td>
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<td>32.6</td>
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<td>50.8</td>
<td>58.5</td>
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<td>Fishery:</td>
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<td>16.5</td>
<td>19.0</td>
<td>24.6</td>
<td>20.5</td>
<td>31.2</td>
<td>26.9</td>
<td>7.9</td>
<td>9.1</td>
<td>10.0</td>
</tr>
<tr>
<td>TNM</td>
<td>119.3</td>
<td>121.5</td>
<td>210.0</td>
<td>327.2</td>
<td>273.0</td>
<td>323.4</td>
<td>305.0</td>
<td>242.7</td>
<td>230.8</td>
<td>275.9</td>
<td>432.9</td>
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<td>Mining:</td>
<td>236.6</td>
<td>205.4</td>
<td>209.6</td>
<td>181.7</td>
<td>226.3</td>
<td>347.0</td>
<td>322.4</td>
<td>300.6</td>
<td>302.1</td>
<td>373.1</td>
<td>326.8</td>
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<tr>
<td>Total Exports</td>
<td>428.1</td>
<td>400.4</td>
<td>524.9</td>
<td>584.0</td>
<td>639.1</td>
<td>637.4</td>
<td>637.9</td>
<td>546.6</td>
<td>546.5</td>
<td>668.3</td>
<td>799.1</td>
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<td>GDP</td>
<td>816.5</td>
<td>872.4</td>
<td>1068.4</td>
<td>1298.5</td>
<td>1413.3</td>
<td>1632.5</td>
<td>1708.1</td>
<td>1696.9</td>
<td>1764.7</td>
<td>1967.2</td>
<td>2172.7</td>
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<tr>
<td>Export/GDP</td>
<td>(52)</td>
<td>(46)</td>
<td>(51)</td>
<td>(45)</td>
<td>(45)</td>
<td>(39)</td>
<td>(37)</td>
<td>(32)</td>
<td>(31)</td>
<td>(34)</td>
<td>(37)</td>
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<tr>
<td>TNM Exp/GDP</td>
<td>(15)</td>
<td>(14)</td>
<td>(20)</td>
<td>(25)</td>
<td>(19)</td>
<td>(20)</td>
<td>(18)</td>
<td>(14)</td>
<td>(13)</td>
<td>(14)</td>
<td>(20)</td>
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<tr>
<td>Ag./Export</td>
<td>(23)</td>
<td>(33)</td>
<td>(35)</td>
<td>(49)</td>
<td>(36)</td>
<td>(43)</td>
<td>(36)</td>
<td>(30)</td>
<td>(30)</td>
<td>(33)</td>
<td>(48)</td>
</tr>
<tr>
<td>Min./Export</td>
<td>(55)</td>
<td>(51)</td>
<td>(40)</td>
<td>(31)</td>
<td>(35)</td>
<td>(54)</td>
<td>(51)</td>
<td>(55)</td>
<td>(55)</td>
<td>(56)</td>
<td>(41)</td>
</tr>
<tr>
<td>TNM/Export</td>
<td>(28)</td>
<td>(30)</td>
<td>(40)</td>
<td>(56)</td>
<td>(43)</td>
<td>(51)</td>
<td>(48)</td>
<td>(44)</td>
<td>(42)</td>
<td>(41)</td>
<td>(54)</td>
</tr>
</tbody>
</table>

Notes: (i) Copra (includes coconut oil); (ii) Fishery (tuna and prawns); (iii) TNM (Total non-mineral); (iv) Numbers in parentheses are percent share (%).

Sources:
(i) Bank of Papua New Guinea, Quarterly Economic Review, (various years).
(iii) Daniel, P. and Sims, R. (1986), Table A22, p.139.
3.3.1 Resource Earnings of Papua New Guinea

About 80 per cent of Papua New Guinea's population is engaged in the subsistence sector though some 70 per cent of subsistence farmers also grow cash crops. The economy is open with its exports traditionally made up of agricultural commodities. Since 1973, however, minerals have made the major contribution to export revenue. The share of exports to GDP has been falling since 1974 (Figure 3-1). Mineral exports as a share of GDP fell from 1974 to 1977, and began to show a slight increase in 1978. In contrast, the share of agricultural exports increased between 1975 and 1977, but decreased again in 1978 to the 1980s. In general, the non-mineral export share of GDP showed a falling trend from 1977 to the early 1980s (Figure 3-1). The prices of both agricultural and mineral commodities are determined by supply and demand in world markets; thus Papua New Guinea is a price-taker. Because of its relative smallness, coupled with its openness, Papua New Guinea is vulnerable to fluctuations in the world economy.

Exports and Gross Domestic Product

Papua New Guinea's GDP showed some growth in the 1970s, followed by a slight fall in 1981. New economic activities were initiated during the period, two of the most important being the mining projects in the North Solomons and Western Provinces. Other private and public investment grew modestly, maintaining a steady trend in GDP (Table 3-1).

The Papua New Guinea Governments have been aware of the effect of fluctuations of commodity prices on the economy. Hence, the "macroeconomic policy framework has been designed to provide as much as possible a steady trend in incomes and demand that is conducive to economic growth, a relatively low rate of inflation, adequate levels of international reserves and a safe level of debt service, throughout the commodity price cycle" (Department of Finance, 1982: 1).

Agricultural Commodity Exports

Papua New Guinea was, until 1973, primarily an agricultural commodity producer with a high dependence on a relatively few primary commodities, namely copra, cocoa and coffee. Since then, the mineral sector has made a major contribution to export earnings. Table 3-1 shows the trend of domestic export earnings for the period 1974-84. Clearly there was a falling trend in the agricultural export earnings from 1977 onwards, with the 1983 earnings falling by almost 30 percent from the 1977 level (see Table 3-1). This fall in agricultural export earnings resulted from low commodity prices. Almost all of

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3 The Bougainville mine is situated in North Solomons while Ok Tedi is in the Western Province. In the late 1960s and early 1970s, the construction stage was well underway in Bougainville. Construction for the Ok Tedi mine began in the early 1980s.
Figure 3-1: Export Earnings as Share of GDP, 1974-1984.

Figure 3-2: Major Sector Earnings as Share of Exports, 1974-1984.
Papua New Guinea’s major agricultural exports experienced falling prices over this period, with the possible exception of palm oil. The total non-mineral earnings as a share of exports is similar the trend in agricultural share. Since agricultural earnings is a major component of the non-mineral share this trend is expected (Figure 3-1).

Mineral Exports

The share of mineral earnings in exports was fairly high in 1974, however, there was a substantial fall in this share in 1975 to 1977. In 1978 there was an improvement in the share of mineral earnings. This trend was maintained until 1983 when there was another fall (Figure 3-2).

3.3.2 The Terms of Trade

Commodity Terms of Trade

Commodity or barter terms of trade are used to assess the impact of changing international prices on an economy. The most frequently used formulation is in the form of the ratio of indices of an economy’s export and import prices $\frac{P_x}{P_m}$. A rise in this ratio indicates an improvement in a country’s barter terms of trade. A fall implies a deterioration. An improvement in the terms of trade indicates that a greater quantity of imports can be obtained for a given volume of exports resulting in a gain in real income to the economy. A deterioration correspondingly results in a loss of real income. A change in the barter terms of trade is, however, not a sufficient condition for gains or losses to an economy; the quantity and quality of exports, and the economy’s competitiveness in international markets also have an effect. A quantity correction is therefore often used with the barter terms of trade to indicate the “import capacity” of a country’s exports. This formulation is defined as $\frac{P_x}{P_m} \times Q_x$, where $Q_x$ is the export quantity index. This concept is the “incomes” terms of trade.

Incomes Terms of Trade

The concept of incomes terms of trade provides a measure of changes in an economy’s import capacity in terms of its export earnings. This measure, however fails to bring out the importance of changes in the terms of trade resulting not only from price and quantity changes but also from changes in productivity. The formulation $\frac{P_x}{P_m} \times Z_x$, where $Z_x$ is a productivity index of export gives rise to the ‘factorial’ terms of trade. This concept can be further refined to account for productivity changes in exporting countries in relation to countries that are the source of imports, or double factorial terms of trade.

In practice even barter terms of trade are difficult to measure, and analysis is usually therefore confined to this measure. Import and export price indices are calculated for most countries. Barter terms of trade is thus employed to assess the impact of changing international commodity prices on the Papua New Guinea economy.
Figure 3-3: Agricultural Commodity Trend for Papua New Guinea, 1969-1983.

Figure 3-4: Terms of Trade (TOT) Trend for Papua New Guinea, 1969-1983.
Figure 3-5: Agricultural Commodity Trend for Papua New Guinea, 1969-1983.

Figure 3-6: Terms of Trade (TOT) Trend for Papua New Guinea, 1969-1983.
Barter terms of trade for agricultural commodities

The barter terms of trade for Papua New Guinea's major agricultural commodities were calculated for 1969-1983. The period of analysis extends over 15 years with 1969 and 1977 as base years. Figure 3-3 shows the trend of commodity terms of trade with 1969 as base year. There was evidence of fluctuations between 1972 and 1975, and 1975 and 1982. The trend shows favourable barter terms of trade for almost all major agricultural commodities in 1973, 1977 and 1982. Coffee and copra show greater fluctuations than other commodities.

When 1977 was used as the base year, we find a smoother terms of trade trend for most commodities with the possible exception of coffee before 1977. Figure 3-6 depicts greater fluctuations for coffee between 1969 and 1977, while all other commodities show a relatively stable trend. The important feature of Figure 3-6 is that the barter terms of trade deteriorated in the 1980's.

In the years 1969 to 1983 barter terms of trade deteriorated in 1972 and 1976. With 1969 as the base year as in Figure 3-3, we find that there were improvements in the terms of trade from 1973 to 1975 but a fall in 1976, and from then on there were fluctuations. A similar pattern in the terms of trade was depicted in Figure 3-4.

3.3.3 Commodity Earnings Instability

Table 3-2 shows the comparison between Papua New Guinea's commodity price instability and the 'average' instability for developing countries. The commodity instability indices for Papua New Guinea have been derived using a similar formula as those used for other developing countries [UNCTAD, 1984: 7]. The following formula was used:

\[ \frac{\sum_{t=1}^{N} |y_t - \bar{y}_t|}{\bar{y}_t} \times \frac{1}{N} \times 100 \]

where \( y_t \), \( \bar{y}_t \), and \( N \) are the actual magnitudes of the variables, its logarithmic trend level and the number of observations, respectively.

Not surprisingly, Papua New Guinea as a country in the early stages of development shows commodity instability indices higher than the average for developing countries, for the period 1971 to 1980. Food products show higher instability than agricultural raw materials such as rubber and wood products. Mineral ores, notably copper ore, show the highest instability. Papua New Guinea's high dependence on mineral exports also increases export instability in comparison to the average for developing countries.
Table 3-2: Commodity Earnings Instability Indices: Papua New Guinea and Developing Countries, 1970-1983.

<table>
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<tr>
<th>Commodity group/type</th>
<th>Papua New Guinea&lt;sup&gt;(a)&lt;/sup&gt;</th>
<th>Developing Countries&lt;sup&gt;(b)&lt;/sup&gt;</th>
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<tbody>
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<td></td>
<td>1970-83</td>
<td>1971-83</td>
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<tr>
<td><strong>Foods</strong></td>
<td></td>
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<tr>
<td>Copra</td>
<td>25</td>
<td>28</td>
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<tr>
<td>Copra oil</td>
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<td>Cocoa</td>
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<td>Coffee</td>
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<td><strong>Agricultural products</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>Wood products</td>
<td>15</td>
<td>17</td>
</tr>
<tr>
<td><strong>Minerals ores</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Copper ore</td>
<td>50</td>
<td>48</td>
</tr>
</tbody>
</table>

Notes:
(a) Indices derived from the formula described in the text.
(b) From UNCTAD (1984), Table 2, p.7.

3.4 Export Instability and Development Patterns: Some Empirical Results

3.4.1 The Data and Measurement of Development Variables

Data for 23 years, from 1960 to 1983, including GDP, government and private final consumption expenditures, gross fixed capital formation, imports, capital inflows and savings were used to calculate the impact of export instability on the economy [see Appendix E]. When trend deviations of these variables are regressed on those of exports, a positive or negative relationship will emerge, and this depicts the relative movements of these variables against movements in exports.

Complete annual data for some relevant economic variables were available only for a 15 year period (1970-1984). These variables include major components of government revenue: domestic, tax and non-tax revenue sources. Within the tax revenue source we have included three sub-categories: the MRSF, company tax and taxes on goods and

<sup>4</sup>We use the categorization of tax and non-tax revenue sources adopted by Garnaut and Baxter (1983, p.123). In general, non-tax sources refer to indirect taxes, while tax revenue sources refer to direct taxes.
services. The two sub-categories of taxes within the non-tax source are the export taxes and taxes on income from investments. The reasons for including these revenue sources are: firstly, to determine the relative movements of these variables against exports; and secondly, to find out which of these variables are the channels of transmission of export instability into the Papua New Guinea economy.

Export fluctuation as deviation from trend

Because this study deals with an individual country, export fluctuations have been measured as deviations around the trend. Other variables that are regressed against export instability have been measured in the same way. The deviations from trend have been derived through the regression of the natural logarithmic values of these variables against time,

\[ \log(y_t) = a + bt \]

where \( y_t \) is the actual value in the time series, \( t \) is time, \( a \) is the constant, and \( b \) is the coefficient. The regression against time gives the fitted values \( (y_t') \) for each observation in logarithmic form. We then take the antilog of the fitted values to derive the numerical fitted values \( (\hat{y}_t) \) without logarithmic transformation. The deviation from trend is the actual \( (y_t) \) minus the fitted \( \hat{y}_t \) numerical values - i.e. \( y_t - \hat{y}_t \). If the trend deviation of exports affect any of these variables, then the movements of these variables must at least eventually follow that of exports.

3.4.2 Major Component of Development Variables

Gross Domestic Product

The GDP measures the total value of all production in Papua New Guinea. It is widely argued that fluctuating export earnings adversely affect a country's GDP, and therefore its growth and development. In Papua New Guinea, about 40-45 percent of GDP comes from export earnings. Thus, to see the kind of effects export instability would have on GDP, we regress the deviations from trend of GDP \( (\Delta Y_t) \) against the export trend \( (\Delta X_t) \). The ideal measure would have been GNP as this would have excluded factor incomes accruing abroad.

Equation (1) in Table 3-4 shows a very high \( R^2 \) indicating a strong relationship between GDP fluctuations and export fluctuation in Papua New Guinea. About 93 percent of the change in the dependent variable is explained by the relative change in the independent variable. The t-ratio is also significant at both the 1 and 5 percent levels of significance. The coefficients suggest that if there was a 1 percent change in exports this would lead to .87 change in GDP. The common concerns regarding the destabilising effects of export fluctuation on the economy are thus supported.

Government Expenditure
Table 3-3: Export Instability, Growth and Development Variables in Papua New Guinea.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Dependent</th>
<th>Constant</th>
<th>Independent</th>
<th>$R^2$</th>
<th>D.W.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>$\Delta Y_t$</td>
<td>.44</td>
<td>$0.87 \Delta X_t$</td>
<td>.93</td>
<td>1.90</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>$\Delta GE_t$</td>
<td>-2.16</td>
<td>$0.19 \Delta X_t$</td>
<td>.49</td>
<td>1.17</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta GE_t$</td>
<td>-16.88</td>
<td>$0.14 \Delta X_{t-1}$</td>
<td>.79</td>
<td>1.62</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>$\Delta PE_t$</td>
<td>2.11</td>
<td>$0.03 \Delta X_t$</td>
<td>.52</td>
<td>1.38</td>
<td>23</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta PE_t$</td>
<td>2.55</td>
<td>$0.13 \Delta X_{t-1}$</td>
<td>.52</td>
<td>1.36</td>
<td>22</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td>$\Delta FI_t$</td>
<td>1.26</td>
<td>$-0.12 \Delta X_t$</td>
<td>.38</td>
<td>1.75</td>
<td>23</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta FI_t$</td>
<td>3.54</td>
<td>$-0.84 \Delta X_{t-1}$</td>
<td>.34</td>
<td>1.65</td>
<td>22</td>
</tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta FI_t$</td>
<td>6.67</td>
<td>$-0.13 \Delta X_{t-2}$</td>
<td>.35</td>
<td>1.52</td>
<td>21</td>
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<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>$\Delta M_t$</td>
<td>-9.56</td>
<td>$0.19 \Delta X_t$</td>
<td>.30</td>
<td>1.56</td>
<td>23</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$\Delta M_t$</td>
<td>-16.48</td>
<td>$0.32 \Delta X_{t-1}$</td>
<td>.48</td>
<td>1.85</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(6)</td>
<td>$\Delta KI_t$</td>
<td>.60</td>
<td>$0.04 \Delta X_t$</td>
<td>.38</td>
<td>2.00</td>
<td>23</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7)</td>
<td>$\Delta S_t$</td>
<td>8.69</td>
<td>$0.05 \Delta X_t$</td>
<td>.79</td>
<td>1.51</td>
<td>23</td>
</tr>
</tbody>
</table>

Notes:
(i) The Cochrane-Orcutt autoregressive transformation was performed on all equations.
(ii) Numbers in parentheses are standard errors.
(iii) ** (significant at both 1% and 5% level); * (5% level of significance); D.W. (Durbin-Watson statistics); N (sample size) and R² (Adjusted R²).

Sources:
Data from:
(i) National Statistical Office (NSO), Quarterly, Summary and National Accounts Statistics, (various years).
Equations 2(a) and (b) attempt to show the relationship between deviations from trend in government expenditure ($\Delta GE_t$) and export trends. The first equation has an $R^2$ of .49 with a significant t-ratio at both the 1 and 5 percent level. When a one-year lag was introduced in the second equation, the $R^2$ improved significantly with the t-ratio remaining significant. Both equations depict the kind of relationship one would normally expect from these variables: that is any change in exports would result in a proportional change in government spending. Given that government spending is closely related to its receipts, of which a significant proportion comes directly or indirectly from the export sector, the results depicted in equation (2) (Table 3-4) are hardly surprising. The results suggest that a one percent change in exports would lead to .19 and .14 percent change in government expenditure, respectively.

Private Expenditure

We attempt to capture the effects of export fluctuations on private consumption expenditure ($PE_t$). Equation 3(a) has a reasonably high $R^2$, but with a very low t-ratio. Equation 3(b) produces a better result with a 5 percent level of significance and a higher $R^2$. However, the economic meaning of this result is not easy to identify. In Papua New Guinea private expenditures are more directly associated with the wage sector than with the export sector. We would expect a significant relationship between export deviations ($\Delta X_t$) and deviations in private expenditure ($\Delta PE_t$) if the bulk of private individuals' earnings were directly derived from the export sector. However, the government sector is the biggest employer, with private individuals employed or directly related to the export sector fairly low in number. Nonetheless, the respective equations show that a one percent change in exports would lead to .03 and .13 percent change in private expenditure.

Fixed Investment

Equations 4(a), (b) and (c) were used to determine the relationship between fluctuations in export earnings and fluctuations in gross fixed capital formation or fixed investment ($\Delta FI_t$). These show a moderately high $R^2$ with a significant t-ratio for the first two equations at the 1 and 5 percent level. However, the relationship is negative suggesting that movements in fixed investment run counter-cyclically to those of exports. The respective results suggest that a unit change in exports would lead to -.12, -.84 and -.13 percent change in fixed investments.

The definition of gross fixed capital formation or fixed investment as 'outlays on additions of new durable goods to stocks of fixed assets' [National Statistical Office, 1978: 44], might explain this rather unexpected result. Large investment projects such as Bougainville Copper and OK Tedi, both of which contribute significantly to the formation of fixed assets, carry out their investment plans with little concern for the short-term fluctuations in export prices. Major mining investments clearly have to take
place before exports from these projects can come on stream. Equations 4(a), (b) and (c) thus give the expected results. Investment data would have to be disaggregated by sectors directly related to the export sector, and long lags would have to be used to obtain a different result to those in equation (4).

Imports

It is generally accepted that fluctuations in export earnings, particularly in developing countries, impose constraints on the capacity to import. For a small, open economy such as Papua New Guinea, whose expenditures on imports run as high as 60 percent of GDP, and which relies to a significant extent on export receipts to pay for imports, the effects of fluctuating export proceeds on purchases of imports are an important policy consideration. Equations 5(a) and (b) show the results of regressing trend deviations of imports ($\Delta M_t$) on those of exports. Both equations are significant at the 1 and 5 percent level with fairly high $R^2$. The results suggest that the movements in export earnings do affect the country’s capacity to import goods and services: a unit change in the export trend would give rise to a .19 and .32 percent change in the imports trend.

Capital Inflow

A close association between the effects of export fluctuation and capital inflows ($\Delta K_{It}$) would be expected. Equation (6) shows a fairly high $R^2$, and a statistically significant and positive relationship between the two variables at the 1 and 5 percent level. The result suggests that a 1 percent change in the export trend would lead to .04 percent change in the trend of capital inflow.

Savings

Equation (7) shows the result when deviations from trend in savings ($\Delta S_t$) were regressed on those of exports. There is a strong relationship between the variables as shown in the $R^2$ and the t-ratio, as both are high and significant at the 1 and 5 percent level, respectively. The result suggests that a 1 percent change in exports would lead to a .05 percent change in savings.

3.5 Export Instability and Economic Growth: Some Empirical Results

Instability as Coefficient of Variation of Exports

Export earnings instability was also measured by using a 5-year moving average of real exports ($\bar{X}_t$) over a 23-year period from 1961 to 1983. The nominal export values were first deflated using the GDP deflator supplemented by the consumer price index (CPI) where the former was incomplete.\(^5\) The 5-year moving average was lagged by two

\(^5\)The Papua New Guinea GDP Deflator was derived from the World Bank’s World Tables while the consumer price indices (CPI) used as proxy for 1974 onwards came from Garnaut and Baxter (1983).
years so that the first observation for 1961-65 period falls on 1963 (the middle year), and the next five years (1962-66) falls on 1964, etc.. The two-year lag was necessary to relate the observations to the middle year of the 5-year moving average.

The two years lag meant that out of the 23-year data period, four years data (the first two and the last two years) were lost. Only 19 years of data were left for actual analysis. After deriving the moving average, the deviation from trend of export ($\Delta X_t$) was calculated for each year of the 19 years data (1963-82) by subtracting the moving average of real exports ($\bar{X}_t$) from the actual real exports ($X_t$).

The next step was to find the standard deviation of each of the 19 year data by using the formula:

$$\sigma X_t = \sqrt{\frac{\sum (X_t - \bar{X}_t)^2}{N-1}}$$

where $\sigma X_t$ is defined as above, and $N$ in this case is 5 (the number of years in each sample). We then derive the coefficients of variation of export earnings for each of the 19 year data by using the formula:

$$Coefficient of Variation (CV) = \frac{\sigma X_t}{\bar{X}_t}$$

where $\sigma X_t$ is the standard deviation, and $\bar{X}_t$ is the 5-year moving average of export earnings as defined above. The coefficient of variation in this case is the measure of export earnings instability.

The nominal GDP figures for 1961 to 1983 were deflated by the GDP deflator to convert them to real values. The real growth rates of GDP were derived as follows: yearly growth rates were calculated by subtracting last year's real GDP value from the current year and expressed in percentage terms as below, where $Y_t$ and $Y_{t-1}$ are the real GDP in the current and last year, respectively:

$$\frac{Y_t - Y_{t-1}}{Y_t} \times 100$$

Because growth rates were found between consecutive years, 2 years of data were lost initially; another 4 years of data would have been lost after completing the calculation for the 5-year moving average rates. To retain as many years as possible some adjustments were made as follows: a 3-year moving average was taken for the first and last three years of the data period with a 1-year lag so that for 1962-64 period 1963 became the first data point while the last data year was 1982 (being derived from 1981-83). The same methodology was used to find the real growth rates of government
expenditure \((GE_t)\), private expenditure \((PE_t)\), gross fixed capital formation \((CF_t)\), imports \((M_t)\), exports \((X_t)\), savings \((S_t)\), capital inflow \((KI_t)\) and total employment \((TE_t)\).

The 5-year moving average growth rates of these variables was regressed against export instability indices, using autoregressive estimation methods (Table 3-4).

3.5.1 Export Instability and Growth: Empirical Results

Regressing the real growth rates of GDP \((Y_t)\) against export instability \((EI)\), the result supported the hypothesis that export instability has a negative effect on economic growth. Equation (1) has a fairly significant \(R^2\) of .65, but the t-statistic is not significantly different from zero.

In equation (2) growth rates of government expenditure \((GE_t)\) were regressed against export earnings instability. The hypothesis that export instability has a negative effect on government expenditure was not supported. The sign was positive. While the \(R^2\) has a high value (.74) suggesting a fairly significant relationship between the dependent and the independent variables, the t-ratio is insignificant suggesting that the parameter estimate for export instability is not significantly different from zero. Given that government expenditure in Papua New Guinea is heavily subsidised by foreign aid from Australia this result is not surprising. We could tentatively conclude that foreign aid which makes up about 30 percent of the Papua New Guinea budget has an offsetting effect on the direct impact of export instability on government expenditure.

While government expenditure is substantially subsidised by Australian aid to Papua New Guinea, private expenditure is not. Thus a negative effect would be expected to be caused by export instability on the growth rates of private expenditure. This is borne out by equation (3). When real growth rates of private expenditure \((PE_t)\) were regressed on export instability, the expected negative sign was found. However, the t-tests show the coefficients to be not significantly different from zero. Similar results were obtained for real growth rates of capital formation and imports against export earnings instability. When real growth rates of capital formation \((CF_t)\) were regressed on export earnings instability, the expected negative sign was again obtained, but the t-tests failed to show this parameter estimate significantly different from zero (equation(4)). A similar result was obtained for real growth rates of imports \((M_t)\) against export instability, though the sign was as expected, the t-tests failed to make the coefficient significantly different from zero (equation (5)).

Equation (6) presents the regression results for the real growth rates of exports \((X_t)\) against export earnings instability. Though there was a fairly significant \(R^2\) of .37, the sign did not support the a priori hypothesis that fluctuating export earnings negatively
Table 3-4: Real Growth of Economic Variables and Export Instability for Papua New Guinea.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Dependent</th>
<th>Constant</th>
<th>Independent</th>
<th>$R^2$</th>
<th>D.W.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>$Y_t$</td>
<td>7.53</td>
<td>-6.40 $EI_t$</td>
<td>.67</td>
<td>2.06</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(-1.30)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2)</td>
<td>$GE_t$</td>
<td>7.11</td>
<td>.90 $EI_t$</td>
<td>.75</td>
<td>1.01</td>
<td>19</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>(.17)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td>$PE_t$</td>
<td>8.33</td>
<td>-5.58 $EI_t$</td>
<td>.47</td>
<td>1.98</td>
<td>19</td>
</tr>
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<td>(1.36)</td>
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<tr>
<td>(4)</td>
<td>$CF_t$</td>
<td>18.63</td>
<td>-2.86 $EI_t$</td>
<td>.44</td>
<td>1.56</td>
<td>19</td>
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<td>(.21)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(5)</td>
<td>$M_t$</td>
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<td>-4.60 $EI_t$</td>
<td>.29</td>
<td>2.11</td>
<td>19</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>(.54)</td>
<td></td>
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</tr>
<tr>
<td>(6)</td>
<td>$X_t$</td>
<td>10.61</td>
<td>44.49 $EI_t$</td>
<td>.41</td>
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<td>(1.59)</td>
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<td>(7)</td>
<td>$S_t$</td>
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<td>12.70 $EI_t$</td>
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<td>(.54)</td>
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</tr>
<tr>
<td>(8)</td>
<td>$KI_t$</td>
<td>2.36</td>
<td>16.32 $EI_t$</td>
<td>.10</td>
<td>1.91</td>
<td>19</td>
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<td>(1.15)</td>
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<tr>
<td>(9)</td>
<td>$TE_t$</td>
<td>8.03</td>
<td>-5.05 $EI_t$</td>
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<td>1.94</td>
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<td></td>
<td></td>
<td>(-1.64)</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Notes:**
(i) All equations are estimated using autoregressive methods.
(ii) Numbers in parentheses are standard errors.
(iii) ** (significant at both 1% and 5% level), * (significant at 5% level).
(iv) $R^2$ (Adjusted $R^2$); D.W. (Durbin-Watson statistics); and N (sample size).

**Sources:**
Data from:
(i) National Statistical Office, Summary, Quarterly and National Accounts Statistics.
affect the growth of exports. The t-tests also failed to find the parameter estimate significantly different from zero.

Similar results were obtained when real growth rates of savings \((S_t')\) were regressed against export instability. The sign of the regression results did not support the hypothesis that export instability has a negative effect on savings. The sign was positive, and the t-tests was not significant in equation (7). Both equations (6) and (7) present contrary results to those expected from the a priori hypothesis, suggesting that stabilisation mechanisms are at work in the Papua New Guinea economy. This is of course the case. The Papua New Guinea government, recognizing the inherent instability of primary exports, has established commodity price stabilisation schemes to minimise the detrimental effects of instability on the economy. The stabilising impact of these schemes is discussed elsewhere [see Lam (1977), (1978), (1980) and (1983), Clunies Ross (1979), and Garnaut and Baxter (1983)].

Equation (8) presents the results when the real growth rates of net capital inflow \((K_t')\) were regressed against export earnings instability. The relationship between the dependent and independent variables as shown by \(R^2\) was a very low value of 0.05. Nonetheless, the sign of the regression coefficient is positive, again contradicting the a priori hypothesis that export instability would negatively affect capital inflow.

Finally, equation (9) presents the results when growth rates of total employment were regressed against export earnings instability. A priori growth of total employment would be expected to be negatively affected by fluctuating export earnings. The reason for expecting a negative sign is that the extent to which the private and the government sectors are able to absorb an increasing or decreasing number of employed persons depends on export earnings among other factors. Less employment would be expected with fluctuating than with stable export earnings. It is thus not surprising that the regression results for equation (9) suggest that export instability has a negative effect on the growth of employment in Papua New Guinea.

### 3.5.2 Growth, Capital Inflow and Terms of Trade

The preceding analysis has mainly concentrated on domestic variables. We now introduce multiple regression analysis and include some external variables to see how these together affect economic growth in Papua New Guinea. The variables included in this analysis are the terms of trade, capital inflows and export earnings instability. The economic growth for Papua New Guinea is estimated as described earlier, while the other independent variables were measured as coefficients of variation from a 5-year moving average. Export instability is measured as coefficients of variation of earnings as described in the earlier section.
Again using the autoregressive estimation method we derived the results presented below. When we regress economic growth (Y_t) against export instability (EI_t), capital inflows (KI_t) and the terms of trade (TOT_t) we get the following results:

\[ Y_t = -53.71 + 3.07 \, EI_t + 0.47 \, KI_t + 0.48 \, TOT_t \]  

(10)  

\[ R^2 = .87 \quad D.W. = 1.97 \quad N = 19 \quad t\text{-ratio in parentheses} \]

Apart from the coefficient for export instability, the other coefficients display the expected sign. On a priori grounds the sign of the export instability coefficient would be expected to be negative. However, this is not the case. The positive sign for the capital inflows coefficient suggests that economic growth is enhanced by the flow of capital from abroad. The t-tests are significant at both the 5 and 1 percent level, suggesting the crucial importance of capital inflows in Papua New Guinea’s economic growth, and confirming the neoclassical view of the role of capital in development.

The positive sign emanating from the terms of trade coefficient suggests that the terms of trade experienced by Papua New Guinea during this period (1961-83) have overall stimulated growth. The t-statistic is significant at both the 5 and 1 percent level. If there was a prolonged deterioration in the terms of trade, we would expect a negative sign for the terms of trade variable. The positive sign suggests that some offsetting effects from capital inflows may have influenced the result.

Have the effects of export instability been 'diluted'?

Equation (10) suggested that export instability has a positive effect on economic growth in Papua New Guinea; this is contrary to the negative sign in equation (1) for the same variables in the simple regression analysis (Table 3-4). It seems, therefore, that the other variables included in the multiple regression analysis, namely capital inflows and the terms of trade, may have some 'offsetting' effects on the export instability variable to make it positive rather than negative. To test the above proposition, economic growth was regressed against these two variables separately with export instability as follows:

\[ Y_t = -30.90 - 0.10 \, EI_t - 0.41 \, TOT_t \]  

(11)  

\[ R^2 = .77 \quad D.W. = 1.85 \quad N = 19 \quad t\text{-ratio in parentheses} \]

When real growth was regressed against export instability and the terms of trade, the terms of trade variable still showed a positive sign with a significant t-ratio and the export instability coefficient showed the expected negative sign with an insignificant t-ratio. The results suggest that omission of the capital inflows variable in the multiple
regression has led to the expected negative coefficient for export instability on economic growth. This implies that the offsetting effects of export instability on economic growth in Papua New Guinea comes from the inflow of capital into the domestic economy.

To test further whether or not the export instability coefficient will still retain its negative sign as in equation (11) above, the terms of trade variable was omitted and capital inflows variable was included instead. Real economic growth was regressed against export earnings instability and capital inflows with the following results:

\[
Y_t = 3.48 + 1.72 \bar{E}I_t + 0.13 \bar{K}I_t
\]  

(12)

\(R^2 = .55\) \hspace{1cm} D.W. = 1.97 \hspace{1cm} N = 19 \hspace{1cm} t\text{-ratio in parentheses}

Equation (12) shows that the coefficients for export instability and capital inflows are both positive with an insignificant t-ratio for the former but a significant ratio for the latter. These results therefore confirm that the effects of export earnings instability on the overall growth of the Papua New Guinea economy are offset by other variables with capital inflow being one such variable.

Intuitively, we would expect that the flow of capital into the Papua New Guinea economy would have some offsetting effects on the overall effect of fluctuating export earnings on economic growth. This is borne out by the results of equation (10), with equations (11) and (12) rendering support. Given that a major component of foreign investment into the Papua New Guinea economy during the period of analysis was by multinational firms investing in the mining sector, we would certainly expect the massive flow of funds to have offsetting effects on the effects of export instability on economic growth. During this period, the Bougainville and the Ok Tedi copper and gold projects were two most important projects whose flow of funds would have provided the offsetting effects, maintaining steady growth even if export earnings in other sectors fluctuated.

3.6 Conclusion

Papua New Guinea suffers from export earnings instability. Export instability is a factor in the relatively low economic growth. However, it was not the only factor affecting growth in the economy. The effects of export instability have been mitigated by the budgetary aid flows from Australia. The flow of private capital during this period has had some offsetting effects when the economy faced a period of deterioration in the terms of trade in the 1970s.

Export instability and the deterioration in the terms of trade in the 1970s was not the only factor affecting economic growth. These were additional to the more common
factors such as the lack of investment capital, skilled and efficient manpower and infrastructure necessary for development. While Papua New Guinea is relatively well endowed with natural resources, it lacks the capital and skills to exploit these resources to achieve maximum development.

The present analysis shows that the concern for fluctuating export earnings in Papua New Guinea is certainly valid. The macroeconomic policy framework has concentrated on stabilising the economy. The agricultural commodity stabilisation schemes may have offset the detrimental effects of export instability. In the absence of these stabilisation policies, the effects of export earnings instability would have been far greater.
CHAPTER 4
MINERAL TAXATION AND INVESTMENT RISKS:
A REVIEW AND COMPARATIVE ANALYSIS

4.1 Introduction

Developing countries that rely heavily on mineral exports have tended to be most exposed to export earnings instability both because mineral prices tend to be more unstable than agricultural prices and because economic diversification of output and exports is particularly difficult in a country depending heavily on mineral exploitation. Generally mineral rich countries suffer from the effects of 'Dutch Disease' where the mineral rents inflate the value of the domestic currency due to the boom in mineral exports. Recent studies [e.g. Corden (1984), Corden and Neary (1983)] have highlighted the resource movements from other sectors to the booming sector. Mineral rents due to a mineral boom, for example, also raise wages so that labour migrates from the low wage agricultural sector to the mineral sector. This migration may lead to low productivity in the agricultural sector.

Mineral projects have traditionally been considered as enclaves in most developing countries. This is generally true because most developing countries lack the industrial and manufacturing infrastructure to be fully engaged in the mining activities. Spin-offs from mining activities are therefore limited so that the host developing country must look for other ways of maximising the benefits from mining.

Fiscal policies and other forms of contractual arrangements between the host country and the investor are now seen as important ways of determining the benefits from mining activities. Because of the high cost of exploration and developing a mine, host countries rely on foreign investors to develop mining deposits. This calls for policies which need to cater for the profit-maximising objective of investors. For mineral development to take place, it is necessary to reconcile the profit-maximising objective of investors with that of the host country wishing to achieve maximum benefit from mineral exploitation.
4.2 Development Problems of Mineral Exporting Countries

The difficulties of sound natural resource development have become much better understood since the attention of economists has turned to the problems of resource development in industrial countries. Studies of the 'Dutch Disease' or 'Gregory Effect' have identified a set of macroeconomic problems that require careful policy action to ensure that the distortions created by resource development do not damage the economy and reduce economic growth, but instead exploit natural resources for growth and development [see Corden and Neary (1983), Corden (1982), Gregory (1976) and Lim, et al., (1986)].

The 'Dutch Disease'

The term 'Dutch Disease' originated relatively recently, after the discoveries of natural gas in the Netherlands in the 1970s. The new discoveries led to some unforeseen effects on the traditional sectors of the economy. The net effect of the discovery or boom in natural gas led to a higher real exchange rate brought about by nominal wage increases, thus squeezing other export industries with a consequent decline in the manufacturing sector [Corden, 1982: 2]. The effects of a booming sector on the rest of the economy are usually analysed by assuming three sectors.

Following Corden (1982), we present a brief analysis of the effects of a booming sector using three sectors: the Booming Sector (B), the Lagging Sector (L) and the Non-tradeable Sector (N). The first two sectors produce tradeables at world prices, and both could also produce importables and exportables. Labour is mobile between the three sectors, wage and rents are flexible within them. A boom in B would raise the aggregate incomes of factors employed in that sector. Assuming some income from the extra income in B is spent, this is likely to lead to extra spending on N (non-tradeables) such that the price of N relative to the prices of tradeables must rise. The net effect is that it draws resources out of B and L into N, and at the same time shifting demand away from N towards B and L. Accordingly, Corden suggests that:

The key conclusion at this stage is that labour will move from L to N, and output of L will fall. If we think of L as manufacturing industry, this is de-industrialisation. Naturally the rents of the specific factor in L will fall. The wage will rise in terms of tradeables and fall in terms of N [Corden, 1982: 7].

If the marginal product of labour rises in B as a result of the boom, the demand for labour in B rises leading to movement of labour out of L to N. This has two effects: (a) the movement of labour out of L lowers output there; and (b) the movement of labour out of N "creates excess demand additional to that created by the spending effect, brings about additional movement of labour out of L into N... The two effects combined, leading to a movement of labour from L to N, bring about, what can be called, indirect de-industrialisation" [Corden, 1982: 8].
Traditional explanations of the effects of a mineral boom

The problems created by a booming mineral sector were traditionally seen in microeconomic terms the following ways:

1. dual wage system, a lower wage rate for the agriculture sector and a relatively high one for the mineral sector;
2. inequitable distribution of benefits from mineral development;
3. not generating adequate economic opportunities (e.g. employment, business-related activities, etc.);
4. more export instability and therefore increasing uncertainties in development planning.

These are some of the problems that a mineral exporting country is likely to experience in addition to the already existing problems of development. Indeed, as Wilson suggests...

... developing countries have recognized that mineral-resource-based projects have few linkages with the rest of the economy. This has led to the realization that if benefits are to accrue to the national economy, they must come through the taxation system. In addition, it has been recognized that many mineral projects can generate substantial returns greater than risk-adjusted supply price of investment (economic rents) \cite{Wilson1984}.

In addition to these traditional problems, there is also the question of optimal use of rents derived from the mineral sector. As Nankani suggests:

In spite of their natural resource wealth, the economic performance of countries exporting nonfuel minerals has been disappointing - they exhibit tendencies toward persistent low agricultural growth, high industrial wages, and low aggregate savings. Moreover, they have not been able to tap the full potential revenues of their mining industries \cite{Nankani1980}.

The development problems associated with mineral exporting economies originate from three principal sources:

1. mineral resources are depletable;
2. the demand for minerals is unstable; and
3. the rents accruing from minerals are subject to unproductive usage.

The exploitation of non-renewable mineral resources creates particular problems of depletion which are often not perceived in developing countries. As a result some development programmes put too much emphasis on the development of mineral resources.

The second problem of unstable demand for mineral exports in the short run leads to instabilities in fiscal revenues as well as foreign exchange earnings. This problem of instability is also common to agricultural exporting countries, but for the mineral
exporting countries it is more pronounced, especially if a country lacks diversified sources of revenue-earnings. This problem is common to both the developing and developed countries but the differences stem from the kind of policies implemented to counter the destabilising effects of mineral earnings. Developed countries have a more diverse resource base than developing countries and are therefore better able to cope with the instabilities facing them. Developing countries have constraints such as lack of resource diversity and have greater difficulties in evolving appropriate policies for instability.

Many mineral exporting countries use revenues generated from mineral exports unwisely. Mineral development leads to high consumption and excessive domestic liquidity. Because countries with mineral resources usually have much easier access to foreign borrowing than other developing countries, they tend to borrow more overseas than less well endowed countries. Mineral resources thus tend to be associated with credit worthiness problems following excessive borrowing. Good management and productive use of mineral revenues must be given priority in planning in order to bring about worthwhile development programmes for the country.

Why lower growth in agricultural production?

In most mineral rich countries, the efforts made to develop the mineral sector far outweigh those made in the agricultural sector. Public resources in terms of human and physical capital are drawn into the booming sector. The agricultural sector thus grows relatively slowly. Despite the stimulus to public revenues, investment in agriculture is neglected. These are the kinds of problems that Gregory (1976), Swan (1978), Corden (1982), Corden and Neary (1983), and Neary and van Wijnbergen (1986) among others have outlined.

Commercial and trade policies become skewed. Import-substitution industries tend to be encouraged, but they are costly because the mineral boom leads to the maintenance of an exchange rate that is related to the high export earnings from minerals and overvalued for manufacturing. Accordingly, these factors "act as disincentives to the growth of both agriculture and nontraditional exports, which become less profitable under such a policy structure and may even produce actual losses" [Nankani, 1980: 8].

A second source of the low level of growth in the agriculture sector in the mineral exporting economies results from wage dualism. Mining is traditionally a high wage sector in comparison to the agriculture sector. The wage rates in mining are pushed up, increasing the average wage earned by workers in mineral exporting economies. Migration from low wage sector to the high wage sector is inevitable. As wages rise excessively, unemployment and underemployment tends to occur.

Sources of export earnings instability

Given the nature of the mineral markets and their demand conditions, revenue
instability is a major concern facing mineral exporting economies. Revenue instability arises because of three major factors:

1. mineral supplies cannot be increased in the short run:

2. demand elasticity for minerals is so low that it is not significantly responsive to price changes; and

3. demand for minerals can vary widely over the business cycle | Nankani, 1980: 9 |

The instability in export earnings caused by mineral revenue fluctuations implies that strong countervailing policy measures are needed. Falls in export earnings mean lower revenues, frequently leading to budget deficits, with a consequent tendency to inflation. Alternately external borrowing is common to finance budget and balance of payments deficits. Frequently both inflationary financing and external borrowing ensue. Macroeconomic policy is thus an important instrument in maintaining price stability and at the same time counteracting the effects of revenue instability which are otherwise likely to disrupt development planning and programmes in the mineral exporting economies. Indeed, instability arising from mineral revenues, has had some impact on macroeconomic stabilisation policies in a country such as Papua New Guinea as will be seen in later sections of this study.

4.3 Mineral Development and Risks in Developing Countries

Exploration of mineral resources takes place in many developing countries. However, not all successful exploration is developed into full-scale mining projects because a number of risks facing the investors cannot be overcome. In general some important reasons for limited development of mineral resource projects in developing countries have to do with the degree of risks involved. The impact of tax regimes must be distinguished from project-related risks, both of which are distinct risks but impinge upon the decision of investors. Project-related risks are risks directly related with the project such as its technical and economic conditions, and generally any risk before tax considerations come into the picture. These types of risks will be discussed later in this section.

Because of the degree of risks involved, all mining companies having found a sound mineral prospect require that mining agreements specifying government policy are signed before they commit funds for mineral development. As developing countries have become more exposed to the economic and financial issues facing them and mining companies, they have been able to assert more influence in mining negotiations than in the past. Host developing country objectives have moved beyond mere mining considerations to broad development objectives. Recent mining agreements have incorporated clauses with regard
to environmental protection, employment, localisation and skill training. Such additional objectives often make mining agreements difficult to negotiate; mining companies' objectives are to mine minerals at the lowest (long run) cost possible. Investors still seek to maximise their profit, but they include the wider objectives of host governments among their costs | see Zorn, 1981: 239 |.

Mining Agreements

Developing countries have moved to the negotiation of mining agreements not only to ensure that their development objectives are not overridden but also to obtain as much of the resource rent accruing to a given project as possible. Developing countries are generally dissatisfied with the distribution of benefits from mineral development | see Hughes, 1975: 811 |. The division of the resource rents is complicated when foreign investors have a total or dominant share in a mine. In the past foreign investors were able not only to earn a 'normal' profit, but also to appropriate the bulk of any resource rents. This led to extreme tension between host country and investors, usually culminating in nationalization of the resource.

Developing countries, however, have to take into account that traditionally resource rents were used to finance exploration and to cover project and sovereign risk. Mining investors therefore argue that they have to continue to participate in resource projects to benefit from rents to cover these costs and risks otherwise future mineral development would be curtailed. Investors are also aware that excessive claims may lead to nationalisation of mining. Given these constraints, investors and host countries consider their bargaining positions very carefully. The difficult nature of negotiations requires that stability in mineral policies and particularly fiscal regimes is essential. By reducing uncertainty in government policy, host countries can strengthen their bargaining positions so that attention focuses on the risks associated with a particular project. Investors will accept some risk provided they receive reasonable compensation for these risks.

The evolution of natural resource taxation in developing countries

Some forms of resource taxation have a long history. Resource taxation takes many forms. However, the objective is always the same; that is, to secure part of the resource rent to the resource-owner. In mineral exporting countries, resource taxation is an important component of the fiscal framework. Gillis notes that:

In an earlier era, problems of natural resource taxation in LDCs consisted largely of securing effective applications of two forms of tax instruments (income tax and royalties)... But by 1980 there had been substantial proliferation both in the variety of tax devices employed and in the nature of investments in LDC resource extraction. A complex array of 'windfall' taxes and tax-like devices are now employed to capture rents... Gillis, 1981: (i) |.

Gillis suggests that several countries preferred "windfall" tax as a single tax device
that can capture windfall income. These countries include Colombia (coal and uranium), Papua New Guinea (copper and oil), and Indonesia (hard minerals) [Gillis, 1981: 30].

A fiscal regime must be neutral. That is, decisions about consumption, production and trade are not altered by taxes. As Garnaut and Clunies Ross (1979, p. 193) suggest: "... a tax system or a tax will be described as neutral if it does not change the ordering of possible investments in their attractiveness to investors from the ordering that would have existed in the absence of tax".

Mineral tax regimes must give adequate recognition to investors' attitudes toward risks. As Gillis suggests, any resource tax system which recognizes investors' attitudes towards risk can "serve to increase significantly host country returns at high levels of investment in exploration and development by mineral enterprises" [Gillis, 1981: 19].

Mineral resource taxation is now seen as important in generating revenue in mineral exporting countries. The taxation policies vary between and within countries, and even at project level. Differences also exist in taxation on hard minerals and petroleum (soft minerals).

The impact of different taxation regimes on investors' behaviour toward risk are dealt with in numerous articles and books [see Garnaut and Clunies Ross (1975), (1979), (1983); Emerson (1984); Wilson (1984)] and many others. The basic underlying principle of importance is the after-tax return to the initial investment outlay. If the after-tax return promises to give a reasonable return to investment, then there is good reason to undertake the investment; if not, the investment will not be undertaken.

Investors begin by setting a minimum target rate of return necessary to decide whether or not to invest. In most investment projects, a number of evaluation methods are used to assess rate of return likely to be derived from investment. Two most important of these methods are the internal rate of return (IRR) and the net present value (NPV). Both these methods try to account for the degree of risks involved in a project so that investment decisions take due considerations for these risks. A number of factors are commonly seen to be important in choosing the minimum rate of return necessary to influence the investment decision; these include:

1. project risk;
2. fiscal or taxation risk; and
3. political and country risks.

All these factors affect investors' behaviour towards investment in mineral resource development.

Project Risk

Project-related risks are risks associated with the technical, physical and economic
nature of a project. In mining, for example, this covers the physical attributes of the mine such as quality of ore and the costs of extraction. The geographical nature of the mine may also determine the cost of operation and mine development. Price of minerals is another important determining factor. These factors are generally associated directly with the project and therefore the responsibility of management to determine the nature and extent of the risk. The more information the management has on the technical, economic and physical aspect of the project, the better judgement it makes on this type of risk.

**Fiscal Risk**

Tax-related risks are principally risks that arise due to the types of taxation regimes established by the host country. Generally, they deal with the economics of the project after taking into account returns after tax, and are mainly concerned with questions such as - how much return will the investor get after paying tax in the host country? What additional taxes should be imposed on the mining companies? In general, a tax is considered a risk because of the following reasons:

1. it distorts the maximising objective of the investor; and

2. it is subject to change by the host country without consent from the mineral investors or mining companies.

**Political and Country Risks**

Sovereign or country risks take two forms: those that disrupt mining production and marketing such as strikes and civil disorders, and those directly associated with changes in host government policy so that mines are affected ex post (such changes include tax changes, restrictions on foreign exchange dealings and in extreme cases, expropriation).

The mining company has little influence on this type of country or political risk. The host government, however, has a direct influence since it is responsible for the political and industrial relations climate and the settlement of disputes. In this type of risk, it is the host government’s political record in general and its previous dealings with companies which are evaluated by mining companies, particularly if they are moving into the country for the first time. A perception of high political or country risk will lead investors to setting a higher rate of return than they would otherwise demand to invest in the country. Many countries’ history of dealing with corporations makes political risk relatively low. The main concern is with policy that affects mining profitability.

Because of the importance of the ex post changes, mining companies usually insist that a special mining agreement be signed before the development of the mine takes place. Such mining agreements attempt to clarify government policies. If changes occur in the duration of the mine life, the mining companies are aware of the options open to them.
This reason also indicates why mining companies are greatly concerned with arbitration provisions in mining agreements. Such provisions must reduce risk sufficiently to enable mining companies to invest.

4.4 Mineral Taxation and Risks in ASEAN

4.4.1 Mineral Taxation in Indonesia

Indonesia is one of the many developing countries that vests ownership of mineral resources in the state. Mineral resource development includes copper, coal and tin mining, but petroleum is of greatest importance. Petroleum production contributes about a quarter of GDP and just over two-thirds of government internal revenue. Both hard mineral and petroleum production have contributed significantly to Indonesia’s economic growth [see Emerson, 1984: 31].

Indonesia was one of the first developing countries to attempt to appropriate economic rents, doing so through production-sharing fiscal arrangements. In production sharing arrangements the state-owned corporations share total output with the foreign companies which operate the mines. Production sharing is more prevalent in petroleum than in hard minerals as shown in Table 4-1. The Indonesian Government has traditionally been reluctant to accept direct foreign investment in mineral resource development and has instead operated on contracts which maintain its role as mine owners in mining agreements. The Indonesian Government considers that production-sharing gives it a greater say in mineral resource development in the country than other forms of resource taxation. A state-owned corporation (P.N.Pertamina) was established and granted all mining rights. Accordingly, Emerson notes that "production sharing has become the norm between private mining companies and the state" [Emerson, 1984: 32].

This form of contract in Indonesian mining began in 1966 in the so-called First generation contracts in the development of a copper mine in Irian Jaya. Second generation began with the nickel contracts negotiations between 1968 and 1972. The Third generation contracts became operational in 1976. Emerson (1984) notes that the successive generations of mining contracts in Indonesia provide for progressively higher levels of equity participation.

Mineral taxation policies in Indonesia include company tax, royalty, equity participation, production-sharing, income tax, depreciation, progressive profits tax and investment allowances. As Table 4-1 shows, production sharing arrangements predominantly operate in petroleum. Company tax policy is the same for the hard minerals and petroleum sectors, at 35 per cent in the first ten years of mining operation and 45 per cent thereafter. Royalty rates vary between 1.6 to 10 per cent depending on
Table 4-1: Mining Taxation Policies in Indonesia.

<table>
<thead>
<tr>
<th>Tax Policy</th>
<th>Hard Minerals</th>
<th>Petroleum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ownership</strong></td>
<td><strong>State</strong></td>
<td><strong>State</strong></td>
</tr>
<tr>
<td>Company tax</td>
<td>35% in first 10 years,</td>
<td>35% in first 10</td>
</tr>
<tr>
<td></td>
<td>45% thereafter</td>
<td>45% thereafter</td>
</tr>
<tr>
<td>Royalty</td>
<td>varies (1.6% - 3.2% for</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>nickel subject to ore</td>
<td></td>
</tr>
<tr>
<td></td>
<td>content), 10% (tin)</td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td>8.5%</td>
<td></td>
</tr>
<tr>
<td>Production sharing</td>
<td>-</td>
<td>varies 65:9:34:1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>before tax, 85:15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>after tax, 65:35</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(natural gas)</td>
</tr>
<tr>
<td>Income tax</td>
<td>35% - 37%</td>
<td>35% - 37%</td>
</tr>
<tr>
<td>Depreciation</td>
<td>acceleration in first</td>
<td>acceleration option</td>
</tr>
<tr>
<td></td>
<td>4 years</td>
<td>allowed</td>
</tr>
<tr>
<td>Windfall profits tax (WPT)</td>
<td>60% WPT abandoned (1982)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>replaced with 15% PPT</td>
<td></td>
</tr>
<tr>
<td>Dividend withholding tax (DWT)</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>Investment allowance</td>
<td>up to 20% of investment</td>
<td>maximum of 20% deduction</td>
</tr>
<tr>
<td></td>
<td>deductible from income</td>
<td>from taxable income</td>
</tr>
<tr>
<td></td>
<td>at 5% p.a.</td>
<td></td>
</tr>
<tr>
<td>Production bonus</td>
<td>varies</td>
<td>varies</td>
</tr>
<tr>
<td>Tax holiday</td>
<td>up to 3 years</td>
<td>up to 3 years</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>interest payments are</td>
</tr>
<tr>
<td></td>
<td></td>
<td>deductible if less than</td>
</tr>
<tr>
<td></td>
<td></td>
<td>market rates; allowance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for up to 25% production</td>
</tr>
<tr>
<td></td>
<td></td>
<td>for domestic market</td>
</tr>
</tbody>
</table>

the type of mineral and mineral content. For example, the royalty rate for nickel ranges from 1.6 to 3.2 per cent f.o.b. value of output, while it is 10 per cent for tin.

A maximum of 50 per cent local equity is allowed in the hard minerals sector. In the petroleum sector, a maximum of 51 per cent local equity is considered as necessary. In the mineral sector, production sharing arrangements range from 50:50 to 65:35 before tax, and 85:15 after tax, in favour of the state. Income tax rates range from 35 to 37 per cent in both sectors, and accelerated depreciation is allowed in the first four years of mining operations. In addition, tax holidays of up to 3 years are options for mining companies.

A windfall profits tax which was common in the First and Second generation contracts was abolished in 1982, and was replaced by a 15 per cent progressive profits tax. A 10 per cent dividend withholding tax also applies in Indonesia. Another significant feature of the Indonesian tax regime is the investment allowance which allows for up to 20 per cent of total investment to be deducted from taxable income in both the hard minerals and petroleum sectors.

Production bonuses also vary in fiscal arrangements within provinces. Included in the petroleum mining contract is a provision for up to 25 per cent of output for the domestic market.

4.4.2 Mineral Taxation in Malaysia

Mineral ownership in Malaysia is vested in the Federal and State authorities. Malaysia is an important mineral producer. It is a major producer of tin and in the 1970s it became an oil and gas producer. Mining and quarrying accounts for 5 per cent of the GDP. About 30 per cent of government taxation revenue originates in hard rock mining, and another 20 per cent from petroleum.

Malaysian governments have made important changes in the mineral sector since the early 1970s. The state has become involved more directly in mineral development, the government has encouraged greater national involvement in downstream mineral processing, fabrication and marketing, and alterations have been made in the fiscal arrangements for the mining industries [Emerson, 1984: 39].

Petroleum development in Malaysia is subject to production sharing arrangements similar to those of Indonesia. Hard minerals are principally subject to ad valorem export duties and royalties. Royalty rates are 10 per cent f.o.b. value for copper, petroleum and natural gas and 5 per cent for gold. The company income tax rate is 40 per cent for hard minerals and 45 per cent for petroleum. Equity options in hard minerals range from 50 to 70 per cent for private investors. In the petroleum sector production sharing arrangements dominate, varying from 70:30, 75:25, and 80:20 in favour of the host country. Each State negotiates its own mining agreements. Thus there is no uniformity of mining agreement.
<table>
<thead>
<tr>
<th>Tax Policy</th>
<th>Hard Minerals</th>
<th>Petroleum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td>Federal &amp; state</td>
<td>Federal &amp; state</td>
</tr>
<tr>
<td>Company tax</td>
<td>40%</td>
<td>45%</td>
</tr>
<tr>
<td>Royalty</td>
<td>10% (copper)</td>
<td>10% (petroleum)</td>
</tr>
<tr>
<td></td>
<td>5% (gold)</td>
<td>10% (natural gas)</td>
</tr>
<tr>
<td>Production</td>
<td>-</td>
<td>varies 70:30,</td>
</tr>
<tr>
<td>sharing</td>
<td></td>
<td>75:25, 80:20</td>
</tr>
<tr>
<td>Export duty</td>
<td>7% - 16% ad valorem,</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>graduated rate if</td>
<td></td>
</tr>
<tr>
<td></td>
<td>price above threshold</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(maximum 50%)</td>
<td></td>
</tr>
<tr>
<td>Development tax</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>accelerated option</td>
<td>20% in initial year,</td>
</tr>
<tr>
<td></td>
<td>8% p.a. straight line,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40% secondary recovery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>initial year, 6% after</td>
<td></td>
</tr>
<tr>
<td>Profits tax</td>
<td>progressive scale,</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>5%-10%, 15% (tin),</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5% on profits above $200,000 or 25% shareholders' funds</td>
<td></td>
</tr>
<tr>
<td>Reinvestment</td>
<td>25% deduction on</td>
<td>-</td>
</tr>
<tr>
<td>allowance</td>
<td>capital expenses</td>
<td></td>
</tr>
<tr>
<td>Tax holidays</td>
<td>varies within States</td>
<td>varies</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>losses carry forward</td>
</tr>
<tr>
<td></td>
<td></td>
<td>option</td>
</tr>
</tbody>
</table>

Sources: Derived from C. Emerson (1984), pp.39-54.

Export duty in Malaysia is fairly high, ranging from 7 to 16 per cent ad valorem for hard minerals, and 25 per cent in the petroleum sector. A development tax of 5 per cent is also applied in the hard minerals sector with an option for accelerated depreciation. In the petroleum sector, 8 per cent per annum straight line depreciation up to 20 per cent in the initial year of operations is allowed for primary production; while for secondary recovery up to 40 per cent depreciation is allowed, and 6 per cent thereafter.

Profits tax applies in the hard minerals sector, and operates on a progressive scale ranging from 5 to 15 per cent depending on the mineral type. For example, Table 4-2 shows 15 per cent for tin, and 5 to 10 per cent for other minerals depending on the State...
that hosts the mining operations. In general a 5 per cent rate is imposed for profits above M$200,000 or there is an option of a 25 per cent tax rate on shareholders' funds. Similarly to Indonesia's investment allowance, Malaysia has reinvestment allowances with an option of a 25 per cent deduction on capital expenditures. Tax holidays also vary between States and options for losses carried forward are allowed in the petroleum sector.

Mineral taxation regimes vary a great deal among Malaysian States, and among types of mineral. Royalties and ad valorem export duties are relatively high. Emerson suggests that "these act as a deterrent to the development of hard minerals and raise the cut-off grade in operating mines, they under-tax mines that turn out to be highly profitable. In both respects they yield lower amounts of government revenue than could be obtained through the application of a more efficient taxation system for the large-scale development of hard minerals" [Emerson, 1984: 40]. In the petroleum sector, the fiscal arrangements provide disincentives such that "their distorting effects are very strong and it is likely that this has reduced the potential revenue base from petroleum considerably" [Emerson, 1984: 49].

4.4.3 Mineral Taxation in the Philippines

As in most developing countries, ownership of mineral resources in the Philippines is vested in the state. The contribution from mining and quarrying to GDP, however, is less than three per cent. Copper mining is the main mineral activity. The potential for oil and natural gas exploration and production is hampered by varying and unpredictable fiscal regimes. High country risk perceptions raised production costs further. Unlike Indonesia and Malaysia, mineral exploration and development in the Philippines has mostly been undertaken by private domestic companies. Foreign companies have to have at least 60 per cent local equity.

Mining taxation is thus "essentially a device for redistributing rents from among Philippines nationals". Only where foreign investment is important, does "mining taxation take on the more familiar role of appropriating rents for the host country" [Emerson, 1984: 55]. Emerson (1984) and Wilson (1984) discuss the potentially disastrous impact of fiscal regimes in mineral development in the Philippines. Not only are fiscal measures unstable in their applications, but they are also subject to abrupt changes; hence, uncertainty and risks are far greater than in neighbouring countries. Table 4-3 indicates some of the basic features of the Philippines fiscal regime.

The petroleum sector has two rates for company tax, 35 per cent for earnings above 100,000 pesos and 25 per cent if below this amount. In the hard minerals sector, there is the option for writing off expenditure at 25 per cent before tax. Royalty rates ranging from 2.5 to 5 per cent operate exclusively in the hard minerals sector. Production sharing
Table 4-3: Mining Taxation Policies in the Philippines.

<table>
<thead>
<tr>
<th>Policy</th>
<th>Hard Minerals</th>
<th>Petroleum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership</td>
<td>State</td>
<td>State</td>
</tr>
<tr>
<td>Company tax</td>
<td>option for writing off expenditure at 25% before tax</td>
<td>35% (if above P100,000)</td>
</tr>
<tr>
<td>Royalty</td>
<td>2.5%-5% depending on net income before tax</td>
<td>-</td>
</tr>
<tr>
<td>Equity</td>
<td>varies between 40% to 60%</td>
<td>varies between 40% to 60%</td>
</tr>
<tr>
<td>Production</td>
<td>-</td>
<td>varies 60:40 after tax, 67.5:32.5</td>
</tr>
<tr>
<td>Depreciation</td>
<td>varies</td>
<td>10 years straight line basis for fixed assets, 5 years for capital assets</td>
</tr>
<tr>
<td>Export tax</td>
<td>1970: 10% (copper), 8% (chromite &amp; iron ore), 1.5% (gold), 2% (others); 1980: 4% (gold, copper, silver, chromite)</td>
<td>-</td>
</tr>
<tr>
<td>Lump-sum fee</td>
<td>20% of output</td>
<td>varies between 67.5% to 70% of output</td>
</tr>
<tr>
<td>Premium duty</td>
<td>1974: 30% (gold &amp; silver), 20% (chromite), 1980: 20% (all metals)</td>
<td>-</td>
</tr>
<tr>
<td>Investment</td>
<td>varies</td>
<td>varies</td>
</tr>
<tr>
<td>allowance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>cost recovery limited to 90% of gross proceeds</td>
<td>-</td>
</tr>
</tbody>
</table>

arrangements ranging from 60:40 to 67.5:32.5 in favour of the state are common in the petroleum sector. Equity options vary between 40 to 60 per cent in both the hard minerals and petroleum sectors.

Export taxes lack uniformity and are unstable especially in the hard minerals sector. In 1980, some signs of uniformity were emerging (Table 4-3) with 40 per cent for all hard minerals being mined in the country. However, less than a decade later varying rates were to apply to all these minerals ranging from 1.5 per cent for gold, 8 per cent for iron ore and chromite, and 10 per cent for copper. In addition to this, a lump-sum fee of 20 per cent of output in the hard minerals, and between 67.5 to 70 per cent of output in the petroleum sector is paid to the state by mining companies.

In 1974, a premium duty of 30 per cent f.o.b. value of gold and silver, and 20 per cent on chromite was applicable. By 1980, this was changed to 20 per cent for all hard minerals. Investment allowances are in use, but vary a great deal. Cost recovery is limited to 90 per cent of gross proceeds for purposes of taxable income.

Discretionary powers in the Philippines have led to more risk and uncertainty since the mining companies are not sure when the changes will occur. Emerson suggests that:

"Taxing authorities in the Philippines have a large amount of discretionary power in establishing fiscal arrangements for minerals and in varying the arrangements from company to company and from time to time. The frequent ad hoc changes in the arrangements for metallic minerals in particular have created a great deal of fiscal uncertainty in these industries..." Emerson, 1984: 61.

4.4.4 Mineral Taxation in Thailand

Mining and quarrying in Thailand contribute only about two per cent of GDP. Mineral ownership in Thailand is vested in the Crown, but exploration and development is undertaken by the private sector. Fiscal regimes in the Thai mineral sector feature company tax, royalties, business or export tax, municipal tax, tax concessions, depreciation, additional petroleum benefit, and equity options.

The company tax rate in Thailand is 30 per cent for locally registered mining companies, and 40 per cent for international companies in the hard minerals sector. In the petroleum sector, the rate ranges from 50 to 60 per cent. Royalty rates are high in comparison to other ASEAN countries, and they vary according to mineral type. For example, in the hard mineral sector, 30 per cent applies to tin, 10 per cent to lead, 4 per cent to fluorite, and 20 per cent to copper and gold. In the petroleum sector, the rates range from 8.75 to 12.5 per cent. By international standards, these rates are very high and provide a strong disincentives for investors to invest in mineral exploration in Thailand.

In addition to company tax, business or export taxes are also applicable, but
Table 4-4: Mining Taxation Policies in Thailand.

<table>
<thead>
<tr>
<th>Tax Policy</th>
<th>Hard Minerals</th>
<th>Petroleum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ownership</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Company tax</td>
<td>30% domestic, 40% international companies</td>
<td>50% - 60%</td>
</tr>
<tr>
<td>Royalty</td>
<td>30% (tin), 10% (lead), 4% (fluorite), 20% (others)</td>
<td>8.75% - 12.5%</td>
</tr>
<tr>
<td>Business tax</td>
<td>4% (all metals), 1.5% (manganese)</td>
<td>-</td>
</tr>
<tr>
<td>Municipal tax</td>
<td>10% of business tax</td>
<td>-</td>
</tr>
<tr>
<td>Tax concessions</td>
<td>3 - 8 years tax holidays reduction in other taxes depending on size of investment and equity participation</td>
<td>7% discount for first 9 years, 5% next 3 years, and 3% following 2 years on price of petroleum</td>
</tr>
<tr>
<td><strong>Depreciation</strong></td>
<td>20% cost recovery limit</td>
<td>option for capital equipment depreciation</td>
</tr>
<tr>
<td>Additional petroleum benefit (APB)</td>
<td>-</td>
<td>27.5% (10,000-20,000 barrels per day), 37.5% (20,000-30,000), 43.5% (30,000 or more)</td>
</tr>
<tr>
<td>Other</td>
<td>new initiatives for 10% equity, and uniform royalties</td>
<td>losses carry forward for 10 years, interest payments not tax deductible</td>
</tr>
</tbody>
</table>


varying with the types of mineral. As shown in Table 4-4, a 1.5 per cent export tax applies for manganese, and 4 per cent for all other hard minerals. No export tax applies in the petroleum sector as this is covered under the additional petroleum benefit taxes which also vary depending on output of oil. For example, a 27.5 per cent tax rate applies for output of 10,000 to 20,000 barrels per day, 37.5% (20,000 - 30,000) and 43.5% for output greater than 30,000 barrels per day. As in royalties, these rates are very high compared to other mineral exporting countries.

The remaining feature of Thailand’s fiscal regimes in the mineral industry includes depreciation allowance of capital equipment in the petroleum sector, and a 20 per cent cost recovery limit in the hard minerals sector. Tax holidays ranging from 3 to 8 years may be provided, and included in tax concessions are options for tax deduction depending
on size of investment and equity participation in the hard minerals sector. In the petroleum sector, discounts on petroleum price are allowed which effectively mean less royalty payments in the first 14 years of production. The rates of discount are 7 per cent for the first 9 years, 5 per cent for the next 3 years, and 3 per cent for the following 2 years.

Other tax initiatives being discussed are options for 10 per cent equity in the hard minerals sector, and the possibility of uniform royalties for all mineral types. A uniform royalty would not necessarily provide incentives for mineral investment to take place, royalty rates would have to fall. In the petroleum sector, losses are allowed to be carried forward for 10 years for tax purposes. While in some mineral exporting countries, interest payments are tax deductible, in Thailand this is not so in the petroleum sector thus providing additional disincentives for investment.

Emerson (1984) suggests that minerals policy in Thailand is in a 'state of flux'. Fiscal regimes are unstable partly because of a lack of adequate mining legislation. This makes the development of the mineral industry uncertain. Emerson also suggests that the taxation authorities "have large discretionary powers to fix tax rates and to vary them from time to time. Mining investors would face great difficulty in predicting future tax rates and, hence, the after-tax profitability of mining investments..." [Emerson, 1984: 73].

4.5 Conclusion

It is apparent that almost all facets of the taxation regimes in the ASEAN countries violate the condition for stability necessary for investors. Conditions of neutrality also seem to be violated, but this is rather difficult to evaluate since Emerson's study and others like it have not used empirical tests. The study by Wilson (1984) attempts to test the alternative fiscal regimes in the Philippines and Indonesia against those of Papua New Guinea. In any case, it would be reasonable to assume that where instability in taxation regimes exist, the neutrality condition may well have been violated, and in the case of ASEAN countries, this seems to be a problem of considerable proportions.

Although mining legislation exists, in almost all ASEAN countries the taxation authorities have large discretionary powers: thus, changes are common in the fiscal regimes. Even where mining legislation is established to monitor and control mineral exploration and development, the details are also subject to alterations (as in the example of Indonesia and the Philippines changing their royalty rates in each successive mining contract). Such changes and instability in fiscal regimes add to investors' perceptions of increased risks. Indeed, the risks in an environment where discretionary power prevails in the taxation authorities are far greater than where some form of uniformity and stability
in fiscal regimes exists. This is precisely the reason that Garnaut and Clunies Ross (1975, 1979 and 1980), Lloyd (1984), Emerson (1984), Wilson (1984), Palmer (1979) and others have emphasised the need for stability and neutrality in fiscal regimes in the mineral sector.

Because mining is usually a very high risk venture commercially, as well as having a certain degree of geological risk involved, investors normally want to know the policy environment before advanced exploration and development takes place. The degree to which political and country risks enter the investment scene do have an important impact on the policy environment. Political and country risks are especially important to investors because these determine their evaluation of renegotiation in later years after the project has been in operation. Ex post changes to the mining operations are the last thing that mining companies would want; thus, the political or country environment may help them assess the chances of this happening. The more stable the political or country environment, associated with a more predictable fiscal regime, the better it is for mining companies.

The above review has concentrated mainly on the ASEAN mineral exporting countries, and does not represent an overall spectrum of mineral exporting developing countries. Lack of country studies on mineral exporting countries limits us from drawing from a wider spectrum of developing countries. Nonetheless, these countries portray the variety of fiscal regimes found in many mining agreements throughout the mineral exporting countries, so that they appear to be sufficient for comparative purposes. One country whose fiscal regime differs from these countries’ is Papua New Guinea.

The resource rent or additional profits tax

Mining taxation in Papua New Guinea has been the subject of numerous articles and a number of books, some of which are listed in this study. A number of studies have also compared Papua New Guinea’s fiscal regime in the mineral sector with that of other countries. These include Garnaut and Clunies Ross (1983), Emerson (1984), Mikesell (1979), and Wilson (1984) among many others. From these comparisons, it seems that the RRT or the APT which has characterised the Papua New Guinea fiscal regime since 1974 is the best fiscal regime devised so far for collecting mineral rent.

An important advantage of the RRT system is that it is based on revealed profitability, and has the characteristic of adjusting automatically to take a greater proportion of profits if this is in excess of the threshold rate of return. As Palmer suggests:

... the superiority of the RRT over the available alternatives under conditions of uncertainty arises from the fact that it does not depend on ex ante forecasts of expected tax liability but responds automatically and progressively to a wide
range of outcomes; by more efficient risk sharing it maximizes expected rent charges consistent with a decision to invest; and it is more neutral than equal-yield alternatives with respect to investment (or reinvestment) decisions [Palmer, 1980: 258].

A more detailed discussion of the RRT or the APT and its applications will be introduced in Chapter 7. The preceding discussions have focused on fiscal regimes other than the RRT. For all the ASEAN countries studied, Emerson (1984) categorically states that the introduction of the RRT or some form similar to it along with variation in royalties, company tax, and other instruments would have stabilised the fiscal policy environment. The use of a fiscal system based on the RRT would have reduced investors' risk towards mineral exploration and development in these countries. Reduced risks would inevitably lead to increased exploration and development of mineral resources, thus, widening the revenue base of these countries.
CHAPTER 5
RISKS AND MINERAL TAXATION:
THE THEORETICAL FRAMEWORK

5.1 Introduction

Risk and uncertainty are relatively high for individual investors [see Corden (1974), Batra (1975), and Donaldson (1984)] among others. The approaches formulated by Fisher (1930) and Hirschleifer (1965 and 1966) accordingly provide the analysis of investment under conditions of risk and uncertainty. Resource taxation may increase risk and uncertainty elements in mineral investment because it has to reconcile two opposing objectives: that of the resource-owner aiming to maximise revenues and that of the resource-investor aiming to maximise profits.

All entrepreneurial activity is risky, but mining investment is particularly risky for several reasons: the quality and quantity of minerals in a deposit can not be measured accurately; the physical conditions of mining can not be predicted; and the prices of minerals in world markets fluctuate thus exacerbating the difficulty of making judgements about the profitability of mining a particular deposit. Indeed it is difficult to find any "human activities which are not characterised in some sense or other by the presence of risk or uncertainty" [Hertz and Thomas, 1984: 8].

5.2 Export Instability, Risk and Uncertainty: The Definitional Framework

5.2.1 Export Instability, Risk and Uncertainty

Export instability is defined as variability in proceeds that originate from exports. The export earnings to a particular country for many commodities are often uncertain because of variations due to changing domestic and external conditions in commodity markets. Uncertainty is not confined to external conditions alone, but may also include domestic supply conditions due to weather, pests and harvesting conditions. In general, there is supply uncertainty or risk as well as demand uncertainty. These conditions independently or interactively give rise to export instability. Instability tends to be greater in developing than industrial countries because they rely on one or two export products.
In The Pure Theory of International Trade Under Uncertainty, Batra noted that:

Almost every mode of economic behaviour is influenced by uncertainty. The farmer faces uncertainty about weather as well as the product price; the entrepreneur in a mechanised industry is not affected that much by the vagaries of his weather, but by the vagaries of his employees, plant breakdown or even the possibilities of a strike; the number of customers coming to a store on any day is random; at the country level, the foreign demand for its products may be stochastic, or the foreign supply of raw materials may be random. Yet, it is only recently that the economist has begun to analyse the economic decision-making of individuals under conditions of uncertainty [Batra, 1975: 1].

In discussing comparative advantage under uncertainty, Ruffin (1974a) classifies uncertainty in international trade into general price uncertainty and foreign trade uncertainty as follows:

General price uncertainty is not peculiar to foreign trade and arises from the time-consuming nature of production processes. When production is planned it is impossible to know the market price prevailing when the output becomes available. Foreign trade uncertainty arises from trading in world markets; an autonomous decision to export or import does not give rise to certain receipts or payments owing to uncertain spot exchange rates or uncertainty costs in foreign markets [Ruffin, 1974a: 261].

Exporting is generally riskier than producing for the domestic market because there is less information about foreign than domestic markets. Corden considers:

It is often argued that exporting is especially risky owing to uncertainties in foreign demand, and that this justifies government intervention to restrict dependence on exports... On the supply, in so far as risks for different products are independent of each other, risk will indeed be increased through the tendency to production specialisation induced by trade. Perhaps foreign trade is - or appears - especially risky because private traders and producers have less information about foreign than about domestic markets and sources of supply [Corden, 1974: 318-319].

5.2.2 Risk, Uncertainty and Probability

In general usage the terms 'risk' and 'uncertainty' are often used interchangeably, but in the theories of risk and uncertainty clear distinctions between these terms are made. Roumasset (1978, p.13) refers to risk as "a situation where alternative outcomes exist with known probabilities and uncertainty to the case where the probabilities are unknown". Arrow describes uncertainty as that state in which "the agent does not know the state of the world", where the state of the world subscribes to "a description of the world so complete that, if true and known, the consequences of every action would be known" [Arrow, 1971: 45].

In a similar framework, but with particular reference to investment decisions Farrar suggests that:
... both risk and uncertainty refer to a situation in which future outcomes are imperfectly known, the situation is said to be characterised by risk only if the probabilities of alternative, possible outcomes are known. ... To qualify as a risk situation, then, an experiment must be repetitive in nature and must possess a frequency distribution from which observations can be drawn and about which references can be made by objective, statistical procedures. ... uncertainty is said to be present when the experiment in question cannot be carefully replicated by (or upon) other persons or at other times or places; that is, when the situation is unique. Its frequency distribution, therefore, cannot be objectively specified. This is undoubtedly the setting in which most investment decisions take place... [Farrar, 1967: 1-2].

The importance of information

In a more recent book Donaldson (1984, p.143) suggests that both risk and uncertainty denote a "state of limited and questionable knowledge in the world of economic activity. Uncertainty is common in the economic arena because information about variables affecting economic activity is imperfect. Action without a perfect information set requires risk assumption; the degree of risk varies with the characteristics of the information set".

Hirschleifer and Riley (1979) categorised risk into two categories: event uncertainty and endogenous uncertainty. The former is related to the unknowns of events exogenous to the economic system, examples of which are weather, technological change and the political and economic environment. The latter, on the other hand, arises from "imperfections of the economic system itself" this may include market imperfections or inappropriate government policies due to imperfect information or changes in government policy [see Donaldson, 1984: 149].

Just as export instability is often a greater problem in developing than industrial countries, developing countries are high-risk economies compared to the more industrialised countries. The reasons stem from a combination of causes that may be endogenous or exogenous to the economic system.

Risk or uncertainty can be mitigated by information about firms or markets, reducing the degree of uncertainty. This implies that the more information one has about a certain market or firm, the less the degree of uncertainty involving the interactions and transactions involving that market or firm. There is, therefore, a direct link between information gathering and the degree of uncertainty.

A second way of mitigating risk is measures through appropriate economic policies. Measures such as stabilisation funds and resource taxes can reduce risk. In many countries, however, government policies and particularly changes in policy, exacerbate uncertainty.
5.3 A Theoretical Framework for Investment Decisions under Risk and Uncertainty

5.3.1 Risk, Uncertainty and Investment Decisions

The implications of uncertainty on investment decisions focus on three main questions: (1) how individuals value assets with uncertain returns; (2) individuals' initial asset holdings and utility function; and (3) whether to discount public investments in the same way as private investments. In an attempt to clarify these issues, Arrow and Lind made the following observations:

It is widely accepted that individuals are not indifferent to uncertainty and will not, in general, value assets with uncertain returns at their expected values. Depending upon an individual's initial asset holdings and utility function, he will value an asset at more or less than its expected value. Therefore, in private capital markets, investors do not choose investments to maximize the present value of expected returns, but to maximize the present value of returns properly adjusted for risk. The issue is whether it is appropriate to discount public investments in the same way as private investments (Arrow and Lind, 1970: 405).

The basic question that needs answering is: why do individuals, firms or governments invest even under conditions of risk and uncertainty? According to Donaldson ...

... individuals and groups acting under conditions of uncertainty are said to form expectations from limited information about the consequences of economic activity undertaken and the value of those consequences to them. Activities are pursued under conditions of uncertainty because the expected utility from the results of the action is ranked higher than that from alternative enterprises (Donaldson, 1984: 144).

Hirschleifer's (1965 and 1966) studies investigating investment decisions under conditions of uncertainty provide the basic framework for analysing this relationship. Investment is seen in this context as a "present sacrifice for future benefits. But the present is relatively well known, whereas the future is always an enigma. Investment is also, therefore, certain sacrifice for uncertain benefits" (Hirschleifer, 1966: 509).

The subsequent discussion relies heavily on Hirschleifer's reformulation and interpretation of Fisher's (1930) theory of investment decisions. Fisher's theory of investment mainly applied under conditions of certainty. Hirschleifer's contribution was to extend Fisher's theory to include conditions of uncertainty. Hirschleifer formulated a number of approaches to understand the theory of investment under conditions of uncertainty; these will be discussed later, but first the theory of investment put forward by Fisher (1930) is introduced.
5.3.2 Fisher's Theory of Investment Decisions

Hirschi ifer (1965) introduced the essential elements of Fisher's theory of investment decisions in a two-period comparisons between the present (time "0") and the future (time "1"). In Fisher's analytical framework, the object of choice centres on present consumption ($c_0$) and future consumption ($c_1$). The introduction of time-preference and utility functions for the j-th individual, for example, may be represented as $u_j = g_j(c_0, c_1)$, $j = 1, 2, ..., J$. The usual assumption is that each individual attempts to maximize utility within his opportunity set. Three different categories within the opportunity set may be distinguishable: endowment, financial and productive opportunities.

**Figure 5-1: Consumption and Financial Opportunities for Investment**

Endowment and Financial Opportunities

For purposes of illustration, the endowment $Y_j = (y_0^j, y_1^j)$ is the individual's initial position as shown in Figure 5-1; this provides a base point for the analysis of investment as a redistribution of consumption opportunities over time. Current income is represented as $y_0$ and future income as $y_1$, from this we then define investment as $i_0 = y_0 - c_0$. Allowing for financial opportunities to take place, this permits the transformation of endowment into alternative ($c_0$, $c_1$) combinations involving only trade between individuals. In this case, trade is motivated by endowment and income disparities between individuals. Given the differing time-patterns of consumption, a rate of exchange between units of present consumption (in terms of present dollars) and of future consumption (future dollars) would be established in the market. This rate of exchange
can be expressed as \( \frac{(dc_1)}{(dc_0)} = -(1 - r) \), where \( r \) is the rate of interest, or premium on current dollars.

In Figure 5-1, the financial opportunities facing the investor are shown by the market line \( M'M' \) through \( Y \). Along this market line \( W = c_0 + c_1/ (1 + r) \), and this equals \( y_0 + y_1/ (1 + r) \) so that the market line is a budget or wealth constraint. The time-preference optimum for the individual under pure exchange (i.e., financial opportunities only) is \( M^* \), and at the interest rate \( r \) he seeks to invest (lend) the amount \( (y_0 - m_0) \).

**Figure 5-2: Productive Opportunities and Investment**

Productive Opportunities

Allowing for productive opportunities to take place in the opportunity set, it then becomes possible 'to engage in transactions with nature' (e.g., planting seeds), and also at the same time trade with individuals. Given this situation, the investor's utility optimum at \( X^* \) in Figure 5-2 is achieved by a two-step procedure. The investor first moves from his endowment \( Y \) along his productive opportunity locus \( pp' \) to his productive optimum \( p^* \). The productive optimum is characterised by attainment of the highest possible market line, that is, the highest wealth level. Secondly, the investor can then move to his utility optimum \( X^* \), and if need be, this can be done by borrowing. In the case of Figure 5-2, this shows the investor's productive investment as \( (y_0 - p_0) \), and he borrows \( (x_0 - p_0) \) so as to maintain current consumption. Within this productive opportunities process, Hirchleifer concludes that "(it) is the transaction with nature that creates wealth; the associated financial transfers leave wealth unchanged" | Hirchleifer. 1965 : 513 |.
5.3.3 Hirschleifer's Choice-Theoretic Approaches to Investment Decisions

Under Uncertainty

While Fisher's model attempts to explain investment decision under conditions of certainty, Hirschleifer's model takes this a step further to include uncertainty. The concept or term 'choice-theoretic system', as used by Hirschleifer is characterised by the following features:

1. objects of choice (commodities), and decision-making units (economic agents);
2. a preference function ordering such objects, for each economic agent;
3. an opportunity set for each agent, which is equivalent to specifying the constraints upon the agent's range of choice; and
4. balancing or conservation equations, which specify the social interactions among the individual decisions.

Having identified these characteristics, Hirschleifer goes on to say that the competing approaches to the investment decision may differ between investors because of the divergence in their specifications of the basic objects of choice. Hirschleifer (1965 and 1966) used a number of approaches in an attempt to explain investment decisions under conditions of uncertainty.

Asset Preference Approach

The asset preference approach focuses on assets as the 'desired objects of choice'. Within this approach, investment decisions under uncertainty involve purchases of assets involving claims or titles to present and future incomes. Theoretically, comparisons are made in terms of exchanges between riskless and risky assets.

The main advantage of the asset preference approach is that there is a direct link between assets, as usually discussed in investment theory, and commodities in price theory. One fundamental disadvantage of this approach, however, is that assets are not the elemental desired objects; instead it focuses on the relationship between prices of assets and the valuations placed on them by individuals. One other disadvantage relates to the fact that "the total of the various types of assets cannot be assumed fixed, even under pure exchange" [Hirschleifer, 1966: 517].

Mean, Variability Approach

The mean, variability approach as it relates to uncertainty selects as the object of choice expected returns and variability of returns from investment. The basic assumption of this approach is that investors "desire high values of the former and low values of the latter - as usually measured by the mean (µ) and standard deviation (σ), respectively, of the probability distribution of returns and show increasing aversion to µ as risk increases" [Hirschleifer, 1965: 519]. Under these assumptions a preference function can
Figure 5-3: Preference under the Mean, Variability Approach

Figure 5-4: Mean, Variability Approach and One-Security Portfolio
be shown as orderings of all possible \((\mu, \sigma)\) combinations as shown in Figure 5-3. Theorists using this approach have concentrated mainly on the problem of portfolios with very little attention paid to productive assets or investments.

To illustrate the mean, variability approach we introduce here the illustration used by Hirschleifer. Given an opportunity set with \(X\) being the random variable of prospective gross portfolio value resulting from given current investment, possible combinations of \(\mu(X)\) and \(\sigma(Y)\) that could be derived by individual securities are represented by points such as A, B, C, D, E, and F in Figure 5-4.

Point B on the horizontal axis represents investment in riskless bonds. The solid curve represents the efficient frontier, that is, a minimum \(\sigma\) attainable for each possible value of \(\mu\). In general, one-security portfolios are not in the efficient frontier since their expected future value is shown to be greater than that of the others.

The next section of the study looks at the effects of taxation as the first step towards understanding the influence that resource taxation in general, and mineral taxation in particular, have on production and investment decisions. It is also necessary to examine the concept of economic rent as this provides the basic framework for analysing rent taxes. Since the concept of rent arose from the Ricardian concept of agricultural land, it is also necessary to discuss the basic premise underlying this concept.

5.4 Risk and Tax Policy: Some Illustrations

Smith and Ulp (1979) specify three principal objectives of taxation: (1) financing, (2) allocation and (3) stabilisation. The first role of taxation is to do with financing of public services, and this is generally perceived to be the main objective. The allocative role of taxation is used to correct distortions in the market. This role takes on an important function if wide disparities in prices set by the private and public sectors exist.

The other important role of taxation is to stabilise government expenditures. The stabilisation role is seen as providing a steady flow of public services even when the revenue base is subject to fluctuations in revenue sources during the planning cycle. Given the fluctuating nature of mineral prices, and therefore of tax revenues from this source, the stabilisation role of mineral taxation is important.

5.4.1 A General Application of Tax Policy

Economic literature has many discussions of the effects of tax on human behaviour. Standard texts indicate the welfare effects of various tax systems. Such discussions will not be repeated here. The focus is on the effects of taxes on natural resources such as minerals. However, to place the discussion in perspective, it is essential to begin with the basic diagram depicting the effects of a tax in the usual supply and demand framework.
How does a tax affect human behaviour?

The fact that tax affects human behaviour is evident wherever tax payments exist in direct or indirect form. It is generally accepted that taxes have an influence on the allocation of resources. To illustrate this, the effects of taxes are depicted in a simple supply and demand diagram. In Figure 5-5, DD is the demand curve or willingness-to-pay function, and SS is the supply curve or willingness-to-produce function. The willingness to pay and produce represent the voluntary exchanges that may exist in a market-oriented environment. The DD curve depicts that familiar inverse relationship between price and quantity. The SS curve also reveals the familiar positive relationship between price and quantity. The producer’s willingness to produce is matched by the consumer’s willingness to consume at $Q_0P_0$, the point at which the quantities supplied equals quantities demanded. This is the market equilibrium point.

When a tax is introduced into these supply and demand relationships, the market equilibrium is affected. As shown in Figure 5-5, when $t$ (tax per unit) is imposed on the commodity, this drives a wedge between the price that consumers pay and the price producers receive. The amount of tax $t$ is depicted in the shift in the supply curve from SS to $SS’$. This upward shift in the supply curve to $SS’$ reestablishes a new equilibrium point at $Q_1P_1$, where the consumer’s willingness to pay is depicted by $P_1$ and the producer’s willingness to produce depicted by $Q_1$. 

Figure 5-5: Illustrating the Effects of a Tax Policy
The introduction of a tax is shown to result in tax shifting. This is illustrated by the new equilibrium resulting from a change in price due to tax. The actual tax incidence resulting from price changes or resource allocation in the pre-tax or post-tax situations is measurable in actual economic environment. For our illustration, it is sufficient to show that \( P_1 - P_0 = a \) is the increase in price that consumers pay after tax, and \( P_0 - P_2 = b \) is the decrease in price changes depicting the tax incidence to consumers. In percentage terms, consumers bear \( a / (a + b) \) and firms bear \( b / (a + b) \) of the tax burden. In empirical studies which of the two groups bears most of the tax burden depends on the supply and demand relationships.

A tax-induced distortion is experienced when the tax affects the pre-tax allocation of resources. In a situation where this distortion reallocates resources in an inefficient manner, reduction in welfare may result. It is also possible to quantify this social welfare loss to a society or individuals. In taxation terminology, forward shifting occurs when tax-induced changes in prices of final consumption result in consumers reallocating their resources as a result of the price changes. Backward shifting occurs when the tax-induced changes are in payments for factors of production (labour, land, capital and natural resources). As Church suggests, the distribution of the tax burden is dependent on the type of technology used and on markets. In general, tax policy induces reallocation of resources which may result in tax shifting. But in the case of taxes on economic rent "this cannot be shifted onto others and consequently produces no distortion or excess burden" [Church, 1982: 207].

5.4.2 A Tax on Natural Resource Exports

A tax imposed on natural resource exports produced by a firm in a domestic economy complicates the relationships depicted above. The firm involved in extracting natural resources may be domestic or foreign owned. Because of the foreign investment in natural resource extractive industries, the effects of the tax imposed would cut across international boundaries. This means that a tax imposed by the host country or government would affect decisions by investors in another country (or countries) investing in the extractive industry. Thus, we are now dealing with the effects of tax in two or more jurisdictions.

For the purpose of our illustration, and following Church (1982), we look at two jurisdictions involved in the relationship: a host country (taxing jurisdiction) and the world (excluding the host country). A number of assumptions need to be noted:

In most developing countries, mineral resource extraction is predominantly carried out by foreign firms, with some participation from host countries.
1. that the product from natural resource extraction is all exported;

2. that the taxing country has the main aim of maximising tax revenue;

3. that the world or investing country has the main objective of maximising return from investment.

In Figure 5-6, the DD and SS curves depict demand and supply respectively of the natural resource. The SS curve is drawn so as to depict producers developing resources in the resource-rich country having a profitable mineral project (i.e. high-quality and low cost reserves) compared to other parts of the world. Thus, the net demand for the natural resource from the producing country depicted as \(D_n\) is the difference between world supply and demand at the price below the world equilibrium price. Potential revenue is the area above \(P_0\) in Panel B, and the demand curve \(D_n\) represents potential economic revenue accruing to resource investors.

If the producing country introduces a per-unit tax on the resource extracted, this has the effect of increasing production costs so that the supply curve shifts upward as shown by the curve \(S + t\) in Panel B. In the pre-tax situation, natural resource producers in the host country produce \(Q_0\) at price \(P_0\). At that price they have command over the export market share equivalent to amount D in Panel A. Other producers have the share of export market equivalent to amount E. However, the introduction of a tax (t) by the host producing country means an increase in the price of producing that particular natural resource. Thus, as a result of the tax the price increases to \(P_1\) and therefore means that their export share is equivalent to the amount F in Panel A. It is apparent that the effects of imposing a tax on a natural resource product ultimately means a reduction in the market share for that resource since the price of producing it has increased.

**Tax-policy alternatives facing the resource producing country**

In Panel C, the horizontal axis depicts the amount of the resource extracted and corresponds directly with Panel B. On the vertical axis is shown the tax revenue which is \((T * Q)\). The curve GG indicates the feasible tax revenue amount that the producing country would collect at different rates and output levels. In Panel C, tax revenue must equal zero at the pre-tax level of output \(Q_0\). This corresponds to the pre-tax situation in Panel B when \(Q_0\) quantity of the resource was sold for price \(P_0\). If the tax rate is too high in the taxing country, it would mean that the resource producers may no longer profitably operate or produce this natural resource. Thus, the optimal tax rate is shown by the line HH just touching the GG curve. At this point, \(Q_1\) is the quantity that would bring in the maximum tax revenue as shown in Panel C.

The curve HH in Panel C depicts the trade-off points between the conflicting
Figure 5-6: Taxing Natural Resource Exports

Panel A: Taxing country

Panel B: World (excluding taxing country)

Panel C: Tax alternatives for the taxing country
objectives of resource development versus tax exploitation in the taxing country. If, for example, the host country seeks to maximize tax revenues, the preferred tax rate would be at the peak of GG curve. The host country may not necessarily achieve this preferred rate as its objectives are most likely to be in conflict with those of the resource producers who would prefer the tax rate to be as low as possible. Given this conflicting objective between the host country and the resource producers, a compromise would have to be reached for a tax rate which would be satisfactory to both parties. Such a rate would be the point of tangency of the curves HH and GG.

Who bears the tax on natural resources?

In some resource-rich countries, maximizing tax exporting becomes an important objective of natural resource policy. When this occurs producers and consumers outside the host producing country are likely to bear the major tax burden. How nonresidents share in this tax burden is represented in Panel B. The distance a is the difference between the pre-tax and post-tax price which is borne by nonresident consumers. The distance b is the tax burden that is borne by owners of resources, firms and the labour force.

In Panel B, if the world price of the natural resource were to increase to $P_1$, this would bring about additional revenues to producing countries. This increase in price may stimulate additional tax to be imposed. The tax burden borne by consumers as a result of an increase in the world price is the area J in Panel A. Because the price increase originates from the world market, consumers are likely to pay more for a smaller amount of the resource, so that the resulting tax may burden consumers by the entire tax revenue raised in the taxing country.

Are there any losses made due to natural resource tax?

Panel A reveals that net losses to the exporting or producing country is area K. This occurs because there has been an increase in output, thus, using up scarce resources which would be used effectively elsewhere in the country. Area L represents the net loss to consumers since they forego a consumer surplus that could have been derived from a non-tax situation. The owners of the resource extractive firms also experience a loss in net profits or producer surplus depicted by area M in Panel B. Because of the imposition of the tax, their output has been reduced to $Q_1$ a movement from $Q_0$ where no tax applies; thus, they forego area M as producer surplus or net profit. It is apparent that the magnitude of net losses to these groups depends on the supply and demand conditions of the natural resource in the world market.

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2 The term tax exporting refers to the concept of deliberate action of a host government to have the foreign firms bear the major burden of taxes on their activities.
5.5 Risk, Uncertainty and Mineral Taxation

Resource taxation, like other taxes, is a fiscal policy instrument applied by the resource-owner to the investor. More recent literature on resource taxation—e.g. Garnaut and Clunies Ross (1975, 1979 and 1983), Lloyd (1984), Ball and Bowers (1984), and Lloyd and Emerson (1983)—among others have debated the issue of whether or not resource taxation, in particular, the RRT is a penalty against risk taking. The continuing debate rests on the role of resource taxation and its relationship towards risk and uncertainty in investment decisions. Since the introduction of the RRT as an optimal form of resource tax, the debate has escalated with some supporting while others arguing against this hypothesis. New or 'hybrid' forms of RRT are being proposed [e.g. Lloyd (1984) and Emerson (1980)]. The following section deals with an overview of the resource tax, and raises issues about its relationship to risk and uncertainty.

What is Economic Rent?

Any discussion of resource taxation must draw on the question of economic rents. Without rent there would be no justification for resource taxation in resource-extractive industries. Resource rent is commonly defined as "part of the payment to an owner of resources over and above that which those resources could command in any alternative use. Rent is receipt in excess of opportunity cost" [Buchanan, 1980: 3]. Rent and profit seeking are closely allied since both refer to situations in which owners of resources prefer more to less rent and profit. The dynamic aspect of economic rent has been described as follows:

In an ordered market structure, the potential attractiveness of economic rents offers the motivation to resource owners and to entrepreneurs who combine resources into production. And it is the action of entrepreneurs that must drive the system. By seeking always to find new opportunities to earn economic rent and to exploit more fully existing opportunities, profit-seeking entrepreneurs generate a dynamic process of continuous resource reallocation that ensures economic growth and development, again as an unintended consequence. The role of economic rent in a market cannot be properly understood apart from this dynamic [Buchanan, 1980: 5].

Garnaut and Clunies Ross use the term rent as "the profits that remain after deduction of the company income which corresponds to the minimum return necessary to attract private investment to new projects" [Garnaut and Clunies Ross, 1975: 273]. In this context, they also use the term the 'supply price of investment' to describe "the minimum expected rate of return (the minimum weightings reflecting the probability of each outcome’s occurrence) that is consistent with a decision to invest". Both terms the 'supply price of investment' and 'rent' are behavioural concepts, where the former is a function of "normal, competitive returns to investment, of the degree of monopoly in the industry, of the degree of economic and political risk associated with a project, and of investor’s attitudes to risk" [Garnaut and Clunies Ross, 1975: 273].
5.5.1 The Concept of Rent

Smith and Ulp (1979) define economic rent as "the divergence between the market price and the minimum supply price" (Smith and Ulp, 1979: 5). Rent tax is different from other forms of taxes in that rent can be taxed without affecting the price that consumers or producers pay for the resource. It is generally agreed that the RRT has this characteristic. The rent tax is generally perceived in the context of a Ricardian 'economic rent' framework.

Agricultural Rent

Ricardo applied the concept of rent initially to agricultural land, referring "to the reward that a landowner could derive by virtue simply of being a landowner and without exerting any effort or making any sacrifice" (Garnaut and Clunies Ross, 1983: 27). The following assumptions are necessary to represent the concept of rent in a diagramatic form:

1. the marginal cost of agricultural production should increase with any increase in amount of land under cultivation;
2. the price of the agricultural product should be independent of the amount of production;
3. the availability of perfect substitutes for this agricultural product at a fixed price;
4. that land in agricultural use has no opportunity cost;
5. that land fertility is not impaired by private ownership.

Figure 5-7 depicts mc as the aggregate cost curve or the supply curve for the agricultural product in a given territory, and omc is the unit cost of production. At the output level oq, unit cost of production is qr; this is the least preferred option given the high unit cost. The area omcrq is the total cost of producing output level oq. This is the supply price of labour and capital necessary to produce this level of output. The shaded area mcpr is the excess revenue. In principle, this is the amount that could be taxed without affecting the level of output.

It is apparent from the diagram that the amount of rent that accrues to resource owners or producers is determined by the price of the product and the quality of land. For illustrative purposes, if price were to fall from op to op1, rent would subsequently fall

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4 This is discussed extensively by Garnaut and Clunies Ross (1975, 1979 and 1983). Lloyd (1984) and others have also stressed this characteristic of the resource rent tax.

5 From this analysis Garnaut and Clunies Ross (1983, p.28) conclude that economic rent is specific to a particular piece of land and depends on the amount by which the unit cost of production is below that on marginal land.
Figure 5-7: Rent on Agricultural Land

from $pmc$ to $p_1mc$. The amount $mcpr$ is the tax revenue collected without affecting total production level. A rate of $ut$ is imposed on land corresponding to production at $q_1$, while a rate $vw$ is imposed on land corresponding to production at $q_2$. At land corresponding to output level $q$, any rent tax that applies would affect the level of production, as this is the level at which the producer would be at break-even point.

**Mineral Rent**

Lloyd sees the basic concept of resource rent tax as proposed by Garnaut and Clunies Ross focusing on the view that "taxes on mines should be based on mineral rent". Accordingly, Lloyd defines mineral rent as the "difference between the receipts of a mine and the payments to inputs used in the mine production process. It is the income to a mine which is not required as payment in order to attract the inputs used to extract the mine output. Mineral rent arises because of the scarcity of mineral deposits" [Lloyd, 1984: 37]. That is, it is the amount left after normal profits.

The broader concept of economic rent is also applicable to mineral resources. But as Garnaut and Clunies Ross (1983) suggest, this is only when mineral resource output is perceived in terms of output over long periods, and not as annual output as in agricultural resources. The broad concept of mineral rent assumes the following:
Figure 5-8: The Present Value of Mineral Price and Unit Cost of Production

1. property rights for minerals are held by the state;

2. distribution and quality of mineral deposits are known with certainty and constant over time;

3. future costs of production and demand for minerals are known with certainty; and

4. the existence of highly competitive factor markets.

Under these assumptions, the owners of mineral resources are indifferent to whether mineral deposits are extracted now or later. Rent on the marginal project would not fall to zero, since a ton of ore extracted now would not be available for use in the future. Given the assumption of certainty about demand for mineral resources, this means that output levels will be determined by the price and cost of running the mines. In the exploitation of mineral resources, there is an opportunity cost: extracting minerals now or later.

Within this framework, Garnaut and Clunies Ross indicate that "all of the surplus of the mine can be regarded as 'rent' in the sense that it is part of the mine and its removal will not in itself alter decisions on the extent or techniques of production" [Garnaut and Clunies Ross, 1983: 31].
Figure 5-8 shows $op$ as the present value of mineral price which is assumed to be constant over time. The quantity of mineral resources demanded at that price is $oq$ at present or future time $t$. The marginal cost of production is depicted by $mc$, and $q_1$ and $q_2$ correspond to high-cost and low-cost level of production respectively. Rent per unit of output for the high-cost mine is $r_2p$, and $r_1p$ for the low-cost mine.\(^6\)

The main features of the diagram are to illustrate the implications of changes that may result from the cost of mining deposits, uncertainty in demand and distribution of minerals, and insecure property rights to minerals. Garnaut and Clunies Ross claim:

Uncertainty about future demand and price for mineral deposits or about mineral endowments causes prices and rents to be determined on the basis of subjective expectations. The uncertainty itself may raise the private discount rates that are applied to future cash flows, with the complex effects on the rate of production and price of minerals and mineral rent... In general, uncertainty accelerates the depletion of known deposits, and reduces the rate at which new mineral deposits are discovered. [Garnaut and Clunies Ross, 1983: 33].

5.5.2 The Role of Mineral Taxation

In spite of the continuing debates about forms of resource taxation that are optimal for revenue- or rent-earners and neutral for investors, there seems to be general agreement that the basic aim of mineral taxation in developing countries is principally to "establish a stable fiscal framework that, under conditions of uncertainty, obtains a high share of mineral rent for the resource-owner, while at the same time, ensuring for the investor the prospect of a return on his investment commensurate with his risk" [Palmer, 1980: 517].

Resource taxation is becoming an increasingly important fiscal policy instrument in resource-rich developing countries. Garnaut and Clunies Ross have emphasised that in developing countries which have economic opportunities in terms of natural resources, "[the] central task of economic management in resource-based industries is thus to maximise the contribution that these industries make to government revenue" [Garnaut and Clunies Ross, 1975: 272]. Seeking to illustrate issues in natural resource taxation and noting that "allocative neutrality, resource conservation and environmental protection provide additional rationale for taxing natural resource activities", Emerson also adds that "revenue maximisation is an onipresent objective commonly receiving priority in policy formulation" [Emerson, 1980: 124].

The taxation of natural resources involves complex questions regarding the concept of economic rent. "[Any] study of taxation of natural resources must give particular attention to the concept of economic rent... [Roberts, 1967: 198]. Mineral taxation revenue in particular "helps distribute the returns from the export of ore, turning natural resource into new forms of national capital" [Roberts, 1967: 205].

\(^6\)The following analysis follows the presentation by Garnaut and Clunies Ross (1983, pp.30-35).
The Criterion for Neutrality

Given that most investment projects in natural resources involve risk and uncertainty, it is not surprising that in the discussion of resource taxation the concept of neutrality bears much significance. The importance of neutrality is especially crucial in cases where most investment finances originate from abroad. In this context, Garnaut and Clunies Ross suggest that "the ideal of neutrality is that, beyond the changes that would arise from the reduction of disposable income in itself, the tax should not alter decisions on consumption, production or trade". In investment, they suggest that "a tax system or a tax will be described as neutral if it does not change the ordering of possible investments in their attractiveness to investors from the ordering that would have existed in the absence of tax" (Garnaut and Clunies Ross, 1979: 193).

The criterion of neutrality in the application of resource taxation is important for investors. This raises the question of which forms of resource taxation adhere to, or are as close as possible in its application to this criterion. This is a complex issue, and debate continues on the subject. Emerson suggests that:

Only with an understanding of the various principles and concepts associated with natural resource based industries can appropriate revenue sharing measures be devised. Uncertainty, risk taking, the time preference for liquidity, the existence of company hurdle rate and the possibility of earning super-normal profits on the one hand and the concept of marginal project on the other, combine to suggest that taxation should focus on rents. Specifically, rents represented by returns in excess of those necessary to bring forth the supply of the resource, should be taxed heavily. Taxation should spare those profits necessary to induce the decision to invest (Emerson, 1980: 142-143).

The resource-owner will want to obtain the maximum benefit possible from his resources; investors will, however, react adversely to high taxation. A balance between the objectives of the resource-owner and the investor is therefore an important element of any form of resource taxation.  

5.6 Conclusion

The preceding discussions have touched on the relationships between export instability, risk, uncertainty and resource taxation. Essentially, all these involve decisions on production and investment. Undertaking these kinds of decisions under conditions of certainty is clearly different from those under uncertainty or risky conditions. The latter environment implies uncertain outcome, while that of the former gives relatively certain results.

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7The discussions by Garnaut and Clunies Ross (1975 and 1979), Emerson (1980) and Lloyd (1984) among others, provide detailed analysis of the concept of 'neutrality' in the context of the resource rent tax.
Risks affect the amount of investment allocated to various areas of the economy when investors are risk-averse. Assuming rational investment behaviour, investment funds will normally flow to the more secure areas so that the return at the margin is lower than for more insecure areas. In cases where high-risk investment projects are important for development, but funding is limited, growth may be affected if high-risk but potentially high-income investment projects are not attractive. Local and foreign private investors are usually risk-averse. Unless high expected returns are guaranteed, investment will be minimal.

**Diversification as a policy against risk and uncertainty**

Diversification has always been suggested as a counter-measure against risk and uncertainty in investments. The reason for this is derived from the 'Law of Large Numbers'. The logic of diversification is obvious: the more diversified the investment, the more likelihood of a higher average income at lower risk. Diversification pools risk.

In most investment projects, the investor assesses the probability of recovering costs as well as making profits. If the probability of earning somewhat over and above the initial costs does not exist, there is no reason to expect the investor to invest. The relationship becomes more complex when taxation enters into the picture. Taxation in whatever form, adds to the other factors that the investor has to account for to decide whether or not to invest. In many cases, taxation may be the most important determining factor.

Bringing in the country relationships, as is often the case where investment comes from the industrialised country to the developing country to develop a resource, taxation rules and other economic and political factors in the latter are given considerable attention in investment decisions by the investor. This is precisely why the question of 'neutrality' and 'optimality' are considered an important element of any form of resource taxation, or else the tax system penalises investors for undertaking investments. These very questions have proved, and are continuing to be, significant for the mineral sector especially, and the natural resource sectors generally in the Papua New Guinea economy.

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8The Law of Large Numbers: If n identically distributed and independent incomes are pooled, the variance of average income tends to zero as n tends to infinity | see Layard and Walters, 1978: 362 |
CHAPTER 6
MACROECONOMIC STABILISATION AND THE TRANSMISSION OF EXPORT INSTABILITY IN PAPUA NEW GUINEA

6.1 Introduction

In the discussions on export instability and its effects on economic growth in the Papua New Guinea economy, we have concentrated on growth rates of GDP and other broad aggregate macroeconomic variables. It is now necessary to deal with some disaggregated variables such as the private and government consumption expenditure component of GDP.

This chapter attempts to determine the channels through which export instability is transmitted into the Papua New Guinea economy. In presenting the analysis, we start by reviewing the macroeconomic policy framework which provides a perspective on the types of policies applied to deal with economic stabilisation in general, and export instability in particular.

Mineral development in Papua New Guinea will also be examined as this has an important impact on the growth and development of the economy. The MRSF was established in 1974 to stabilise mineral revenue and its role and impact are hence also discussed. The MRSF was set up primarily to provide a mechanism which would stabilise revenue flows from the mineral sector to the yearly government budget. Because of the fluctuating nature of mineral prices in the world market, this mechanism was not only necessary for stabilisation purposes, but it also provides orderly flow of development programs. Given the importance of the mineral revenues for the economy, the empirical analysis tests the effects of the mineral revenues through the MRSF. A related issue is the extent to which the MRSF is a transmission mechanism for export earnings instability.

The impact of other non-mineral revenue sources on the economy is also examined and discussed. This suggests looking at the impact of various revenue sources on export earnings instability. While the time-series data is too limited to enable us to draw any definitive conclusions, the analysis intends to provide an understanding of the concern by successive Papua New Guinea governments with the fluctuating nature of revenues from both the mineral and agricultural sectors.
6.2 Macroeconomic Policy and the Stabilisation Framework

Major economic policies were devised in response to economic circumstances through the 1970s. Some major thrusts of macroeconomic policies will be outlined to place the present analysis in perspective. Given the primary-producing nature of the economy, fluctuations of international commodity prices were an important factor in macroeconomic management in Papua New Guinea. The policies were intended to insulate the economy from these fluctuations which give rise to irregular variations in aggregate demand, instability in government revenues and foreign exchange availability.

Clunies Ross (1979, pp.8-9) argued that stabilisation in the context of Papua New Guinea economy has two main objectives (1) to maintain a steady level or rate of growth of economic activity in the modern sector, and in wage employment; and (2) to restrict the rate of growth of prices. In a similar framework, Guest and Daniel (1981, pp.5-6) have also suggested that the "stabilisation problem of a small developing economy in formal wage employment largely hinges on the ability of the policy framework to withstand the cyclical fluctuations in export commodity prices". Lam (1984) also argued that export instability "created appreciable difficulties for short-term management and control of the domestic economy. In response, successive governments have devised and institutionalised a countercyclical framework, consisting of the mineral and agricultural funds, for the stabilisation of the income flows to the public as well as private sector". Lam, 1984: 15].

Before Papua New Guinea became independent, taxation in general, and resource taxation in particular had little significance as far as government revenue was concerned. The major share of government revenue was in the form of grant-in-aid from Australia. Only in the 1970s has there been some emphasis on generating revenue from domestic sources. Table 6-1 shows the domestic components of Papua New Guinea government revenue over the period 1974 to 1984. The three main sources of government revenue over this period are the direct and indirect taxes and the MRSF.

Almost a decade of political independence has seen Papua New Guinea 'diluting' its dependence on Australian aid from about 80-90 percent in the early 1960s to around 30 percent in the 1980s. As Australian aid gradually diminishes, Papua New Guinea must rely to a greater extent on domestic sources of generating revenue. One of the significant sources of domestic revenue is the taxation of natural resources: taxation of minerals, forestry and fisheries. Compared to other island economies of the South Pacific, Papua New Guinea is relatively well endowed with these resources, thus, taxation of these resources must become an important economic policy instrument. While taxation from forestry and fisheries is not so significant at this stage, mineral taxation has become an important source of government revenue.

The trend depicted in Table 6-1 indicates the growing importance of taxation as a
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<td><strong>Total Tax Revenue:</strong></td>
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<td>1974</td>
<td>117.4</td>
<td>191.0</td>
<td>170.0</td>
<td>96.1</td>
<td>224.4</td>
<td>238.2</td>
<td>329.7</td>
<td>317.0</td>
<td>322.7</td>
<td>328.5</td>
<td>365.8</td>
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<td>64.0</td>
<td>130.3</td>
<td>91.8</td>
<td>49.7</td>
<td>136.0</td>
<td>135.3</td>
<td>214.6</td>
<td>201.3</td>
<td>179.8</td>
<td>161.7</td>
<td>186.4</td>
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<td>Taxes on goods &amp; services</td>
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<td>27.8</td>
<td>34.8</td>
<td>19.5</td>
<td>40.2</td>
<td>46.0</td>
<td>50.2</td>
<td>54.7</td>
<td>61.2</td>
<td>70.1</td>
<td>58.2</td>
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<td>31.0</td>
<td>31.8</td>
<td>41.9</td>
<td>26.1</td>
<td>48.0</td>
<td>56.5</td>
<td>64.3</td>
<td>61.5</td>
<td>81.7</td>
<td>96.7</td>
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<td>Other taxes</td>
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<td>1.6</td>
<td>0.8</td>
<td>0.2</td>
<td>0.5</td>
<td>0.6</td>
<td>0.4</td>
<td>0.9</td>
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<td><strong>Total Non-tax Revenue:</strong></td>
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<td>47.2</td>
<td>43.0</td>
<td>16.6</td>
<td>39.0</td>
<td>46.0</td>
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<td>60.8</td>
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<td>1.9</td>
<td>4.0</td>
<td>4.0</td>
<td>6.1</td>
<td>5.2</td>
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<td>Mining royalties</td>
<td>6.2</td>
<td>2.3</td>
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<td>0.8</td>
<td>2.1</td>
<td>2.8</td>
<td>4.2</td>
<td>3.7</td>
<td>3.4</td>
<td>4.7</td>
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<td>30.6</td>
<td>14.3</td>
<td>15.2</td>
<td>7.5</td>
<td>15.3</td>
<td>24.6</td>
<td>46.1</td>
<td>27.0</td>
<td>17.6</td>
<td>16.0</td>
<td>na</td>
</tr>
<tr>
<td>Fee, fines &amp; rents</td>
<td>7.4</td>
<td>7.3</td>
<td>7.8</td>
<td>4.0</td>
<td>10.3</td>
<td>9.7</td>
<td>12.5</td>
<td>15.3</td>
<td>12.5</td>
<td>14.2</td>
<td>na</td>
</tr>
<tr>
<td>Other</td>
<td>13.1</td>
<td>18.2</td>
<td>13.6</td>
<td>2.4</td>
<td>7.3</td>
<td>3.5</td>
<td>1.4</td>
<td>9.5</td>
<td>26.2</td>
<td>25.0</td>
<td>32.4</td>
</tr>
<tr>
<td><strong>Other Internal Revenue:</strong></td>
<td>179.5</td>
<td>220.3</td>
<td>223.5</td>
<td>150.9</td>
<td>273.5</td>
<td>283.4</td>
<td>343.7</td>
<td>385.8</td>
<td>400.3</td>
<td>391.2</td>
<td>437.0</td>
</tr>
<tr>
<td>BCL flows to MRSF</td>
<td>34.7</td>
<td>62.9</td>
<td>24.6</td>
<td>23.8</td>
<td>21.1</td>
<td>39.4</td>
<td>108.7</td>
<td>71.2</td>
<td>23.2</td>
<td>6.0</td>
<td>24.9</td>
</tr>
<tr>
<td>Flows out to revenue</td>
<td>34.7</td>
<td>45.0</td>
<td>35.0</td>
<td>17.0</td>
<td>31.2</td>
<td>38.5</td>
<td>56.6</td>
<td>81.4</td>
<td>40.0</td>
<td>21.0</td>
<td>29.7</td>
</tr>
<tr>
<td>MRSF/Internal Revenue (%)</td>
<td>(19.3)</td>
<td>(28.6)</td>
<td>(11.0)</td>
<td>(22.5)</td>
<td>(7.7)</td>
<td>(13.9)</td>
<td>(31.6)</td>
<td>(18.6)</td>
<td>(5.8)</td>
<td>(1.5)</td>
<td>(5.7)</td>
</tr>
</tbody>
</table>

Notes:
(i) Years 1974-1976 are in financial years (end of June each year); 1977 (for July-December only).
(ii) Financial year changed from (end of June) to calendar year (end of December) from 1978 onwards.
(iii) MRSF are revenue flows from the Bougainville mine.
(iv) p (provisional); na (not available).

Sources:
(ii) Goodman, R.et.al. (1985), Table A20, p.238.
component of total government revenue. Indirect tax revenue sources are increasingly becoming significant. The flow of funds from the MRSF fluctuates a great deal more than the other components because of the fluctuating nature of the minerals market. The MRSF flows into the yearly budget was designed to stabilise government internal revenue. As Guest and Daniel suggest, "the main 'income' which will fluctuate with export earnings are company profits and government revenues from taxes and dividends". But on a broader scale, "the government's internal revenue tends to fluctuate with the export price cycle, so that a policy of spending the maximum possible current resources on a year-to-year basis would imply fluctuating levels of government expenditure" [Guest and Daniel, 1981: 7-8].

6.2.1 The Agricultural Commodity Stabilisation Funds

Newberry and Stiglitz (1981) point out that the "broad objective of all commodity programmes is to improve the welfare of primary commodity producers, or, more generally the producing countries". They also suggest three reasons for setting up stabilisation schemes:

1. because primary commodity producers face protective policies against agricultural exports by developing countries;
2. because these help reduce risks and uncertainties faced by producers; and
3. because of the need for macro-stabilisation and development [Newberry and Stiglitz, 1981: 12, 14-15].

Commodity price stabilisation has been in operation in Papua New Guinea since the early 1960s. The agricultural stabilisation funds cover the three traditionally important agricultural export crops; namely, copra, coffee and cocoa. A copra stabilisation fund was established in 1962. This scheme formed the basis for two other major agricultural export crops. A coffee stabilisation fund was established in 1966. In 1974 a stabilisation fund for cocoa was also inaugurated. An oil palm stabilisation fund was established in 1984. Initially, the objective of stabilisation was that of stabilising producers' income based upon an industry long term cost of production and this objective was maintained into the 1970s [Department of Primary Industry; 1984: 1].

In periods of above-average prices, levies were imposed on producers by the respective commodity boards. In a downturn in prices below a certain specified price level, the respective commodity boards pay out bounties to producers. The main objective of the stabilisation funds is an attempt to stabilise income of agricultural export producers and so provide an incentive to produce despite the erratic behaviour of commodity prices.

The mechanisms by which Papua New Guinea's commodity funds operate are similar, although each is governed by its own 'formula' agreed upon after discussions
between the producers and the government; and each is incorporated into a 'statute' which governs the operation of the Fund. See Lam (1981) and (1983).

Table 6-2: Commodity Fund Balances and Investments, 1976-1984.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>K million, current prices</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balances(^a):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee</td>
<td>6.8</td>
<td>46.4</td>
<td>63.6</td>
<td>83.8</td>
<td>84.9</td>
<td>90.3</td>
<td>92.1</td>
<td>85.3</td>
<td>82.8</td>
</tr>
<tr>
<td>Cocoa</td>
<td>4.4</td>
<td>32.3</td>
<td>48.9</td>
<td>60.2</td>
<td>61.9</td>
<td>53.7</td>
<td>44.6</td>
<td>44.9</td>
<td>45.9</td>
</tr>
<tr>
<td>Copra(^b)</td>
<td>2.5</td>
<td>4.1</td>
<td>3.4</td>
<td>13.8</td>
<td>7.5</td>
<td>1.7</td>
<td>0.1</td>
<td>0.7</td>
<td>28.5</td>
</tr>
<tr>
<td>Oil Palm(^c)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.9</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>13.7</td>
<td>82.9</td>
<td>115.9</td>
<td>157.8</td>
<td>164.3</td>
<td>145.7</td>
<td>136.8</td>
<td>130.9</td>
<td>164.5</td>
</tr>
<tr>
<td>Investments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banks(^d)</td>
<td>3.0</td>
<td>21.4</td>
<td>37.2</td>
<td>51.5</td>
<td>53.7</td>
<td>46.2</td>
<td>39.7</td>
<td>42.2</td>
<td>72.6</td>
</tr>
<tr>
<td>BPNG(^e)</td>
<td>0.3</td>
<td>49.5</td>
<td>68.4</td>
<td>96.3</td>
<td>102.3</td>
<td>91.0</td>
<td>90.7</td>
<td>83.3</td>
<td>80.3</td>
</tr>
<tr>
<td>Bonds(^f)</td>
<td>10.3</td>
<td>11.6</td>
<td>10.0</td>
<td>9.7</td>
<td>7.9</td>
<td>8.2</td>
<td>6.1</td>
<td>5.4</td>
<td>5.3</td>
</tr>
<tr>
<td>Other</td>
<td>-</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>0.3</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Notes:
(a) End of year balances.
(b) This includes copra board and copra commodity funds.
(c) This scheme only started in 1984.
(d) Investments in commercial banks only.
(e) BPNG (Bank of Papua New Guinea).
(f) Includes Papua New Guinea government securities.

Source:

Table 6-2 shows the stabilisation balances and investments held by the commodity boards and Funds for the years 1976-84. For the three long-established schemes; coffee balances depict an increasing and steady trend; cocoa balances were steady, while in contrast the copra balances were unsteady and became almost exhausted in 1982 and 1983. Since the early inception of these schemes, their total impact on the overall economy have been significant. We can see from the total fund balance of the schemes that from 1976 to 1980 this sum was steadily increasing but fell substantially in the subsequent years to 1983.

The Bank of Papua New Guinea maintains that in times of high commodity prices, the extra income available to producers may lead to demand-induced inflation in the economy. The stabilisation funds could also have destabilising macroeconomic effect by maintaining consumer or import demand even when the export income from earnings are not sufficient to maintain this level of consumption. Such tendencies lead to balance of payments problems. The stabilisation funds are thus also used for macro stabilisation.
The commodity funds are mainly invested in the central and commercial banks in Papua New Guinea with some purchases of government bonds. Over the years, a higher proportion of the funds has been held by the Bank of Papua New Guinea as part of the government's monetary policy. The stabilisation funds held as deposits and investments assist the Bank to control the money supply.¹

6.3 Mineral Development, Fiscal and Exchange Rate Policy

As minerals account for about 40-50 per cent of exports, fluctuations in mineral earnings can be expected to have a significant effect on government revenue and hence on overall development of the economy. This suggests that appropriate policies need to be implemented to cater for the varying objectives of host developing countries and investors.

Fiscal provisions are an important part of any natural resource project for two principal reasons: firstly, they determine the share that resource-investors would be able to receive from their investments, and secondly, they also determine how much the host countries receive as revenue from these projects. These two entities, the resource-investor and the host government have different objectives: the latter wishes to maximise revenues and foreign exchange, while the former aims to maximise profits or returns to investment. In most natural resource projects in developing countries, investors are from outside the country so that a direct conflict exists between these two groups. These conflicting objectives do create difficulties in the negotiation of mining agreements between foreign investors and host governments.

6.3.1 Mining, Investment and Taxation Policy

Mining Policy

The territorial government of Papua New Guinea had no mineral policy and it did not evolve one in the years leading to the production of copper and gold at the Bougainville mine. It was only during the 1974 renegotiation of the Bougainville Copper Agreement that issues affecting mineral development were spelt out "designed to ensure that Papua New Guinea's natural mineral resources are used to promote the welfare of the mass of the people" [Papua New Guinea Government, 1976: 112]. The principles enunciated were that:

1. minerals under the earth and water belong to (all) the people of Papua New Guinea, and the Government and the people must receive a fair price in return for the extraction of these minerals;

¹A detailed discussion of this is in Garnaut and Baxter (1983), pp.128-125.
2. foreign companies, whose expertise and capital are needed for commercial exploitation of mineral deposits, should receive a reasonable return on their investment but any extraordinary gains unrelated to extra company inputs (such as a rise during periods of high world market prices) will go in very large part to the Government; and

3. the Government has the right to regulate the activities of mining companies in such a way as will maximise the benefits of mining to the local community while minimising the potentially harmful social and economic costs | Papua New Guinea Government, 1976 : 112 |

These basic principles were to lay the framework for the renegotiated Bougainville Copper Agreement in 1974 and the Ok Tedi Agreement in 1976.

Foreign Investment Policy

In the years leading to independence, Papua New Guinea had no clear guidelines on foreign investment. The 'Eight Aims' say little on foreign investment beyond calling for "government control and involvement in those sectors of the economy where control is necessary to achieve the desired kind of development" | Papua New Guinea Government, 1976 : 11 |. Foreign investment was welcomed "in line with the overall emphasis on economic growth, but there was no regular machinery for channelling or controlling it. Investments in which the Administration was directly involved, either because it had a financial stake in them or because they were large enough to be considered of major national importance, were negotiated on an ad hoc basis" | Papua New Guinea Government, 1976 : 110 |

The first Papua New Guinea Government (the Somare Government) thus decided to ensure that "foreign investments are only approved if they will result in solid, positive benefits for the people of Papua New Guinea. In other words, foreign investment is not seen as an end in itself, but as a means towards some other end, such as government revenue, export earnings, employment, or the development of industrial skills and infrastructure" | Papua New Guinea Government, 1976 : 111 |. This has continued to be foreign investment policy in Papua New Guinea since 1974. Successive Papua New Guinea governments have generally recognised that without foreign investment, development and growth would be hampered. It is obvious that the main objective of foreign investment policy is to "promote the development of key sectors of the economy while preserving domestic control over those developments and maximising the degree of local participation" | Parry, 1985: 414 |

Taxation Policy

The Somare Government also spelt out some taxation policies within its "integrated package of economic instruments". The objectives of taxation policy were to increase internal revenue so as to reduce dependence on aid, adapt the taxation system to the changes which are occurring in the tax base, ensure that the taxation system reduces

The Bougainville Copper Agreement was renegotiated to meet emerging mineral, foreign investment and taxation policy. Although the changes that were incorporated in the Agreement were major, they were in line with current worldwide practice. They were however innovative in introducing a formula which formed the basis on which the RRT or APT was to be calculated. The APT is paid when a mining company achieves a certain profit threshold rate.²

The Hard Currency Strategy

The hard kina monetary and fiscal strategy was adopted in 1975 when the kina became Papua New Guinea’s national currency, replacing the Australian dollar which had till then been used as currency. As one of the principal architects of this strategy noted some years later: "[The] term was meant to focus attention on the government’s determination to maintain the internal and external purchasing power of the new currency, the kina, at a time when there was much anxiety that monetary independence would mean monetary instability" [Garnaut, 1982: 177]. The hard kina strategy was designed for several purposes. It was intended to limit inflation to avoid the problems that plagued the majority of developing countries as a result of lax monetary and fiscal policies. The maintainance of free convertibility of the kina into foreign exchange was thought essential to attracting foreign investment. It was also considered essential to maintain the foreign exchange value of the kina on average against the world’s major currencies to avoid negative income distribution effects through devaluation | see Garnaut, 1982: 177 |.

Underlying the hard kina strategy were two basic assumptions:

1. that foreign prices and the kina exchange rate were the main determinants of the price level in Papua New Guinea;

2. that Papua New Guinea could choose fairly freely the foreign exchange value it wished the kina to have without running into balance of payments problems | Garnaut, 1982: 178 |.

The first proposition holds to the extent that Papua New Guinea is a small economy, and that imports make up a substantial part of the expenditure on GDP. This is therefore consistent with the characteristics of a small, open economy where one would expect inflation to be transmitted from outside the country rather than within. The second proposition will hold only if public expenditure in real terms were kept at the average real level of internal revenue. Internal revenue components comprise foreign

²Detail discussions of the APT and its applications will be introduced in Chapter 7.
grants (mainly from Australia), indirect and direct taxes levied on enterprises and income-earners in Papua New Guinea, as well as foreign borrowings to meet shortfall in internal revenue.

The basic thrust of the assumptions suggest that "in the absence of exchange rate appreciation, a major part of international inflation will be transmitted rapidly through price effects", while the rest will be transmitted more slowly and indirectly through firms action in maintaining real profits through price increases, and wage-earners collectively maintaining their real wages, and domestic producers charging higher prices for their goods on the domestic markets. It is argued that the appreciation of the kina removes part or all of the direct effects as well as the indirect effects of inflation [see Garnaut, 1982: 179].

The hard kina strategy was pursued from 1976 until 1980 when permissive monetary policy, foreign borrowing and high wage increase led to inflation. During the four years in which the 'hard kina strategy' was in operation, the inflation rate in Papua New Guinea was one of the lowest in the world [Garnaut and Baxter, 1983]. Economic stability which was one of the principal aims of the strategy was maintained but it seemed to have inhibited growth.

The Significance of the Mineral Sector

Since the Bougainville Copper Ltd. (BCL) began production in 1972, the export earnings arising from the mineral sector have contributed significantly to total export earnings of the Papua New Guinea economy. The prices of copper and gold were relatively stable in the early 1970s, but in the late 1970s and early 1980s there were signs of price instability as shown in the fluctuating export earnings during this period. The contribution from the mineral sector was about 68 percent of total export earnings in 1974, but by 1983 this had fallen to a little over 30 percent (Table 6-1).

With the production phase of the Ok Tedi mining (copper and gold) project now underway, the overall contribution from the mineral sector will certainly override that of the agricultural sector. When the Ok Tedi mining project comes into full production in 1987, the Papua New Guinea economy will be highly dependent on the mineral sector, such that any slight fluctuation in prices of copper and gold will be strongly felt. Thus, while a stable price for these mineral resources would significantly contribute to a steady trend in the country's total export earnings, unstable or falling prices would be reflected much more sharply in the total export earnings, and in the overall economic growth.

Problems of unstable mineral prices

The contribution of the MRSF to government revenue varies directly with the movement in the metal prices, in this case, gold and copper. The volatile nature of these metal prices can create both 'optimism' during a period of high prices and 'pessimism'
during a period of low prices, in an economy such as Papua New Guinea. Indeed, Garnaut and Baxter noted that "small open economies like Papua New Guinea are liable to experience large fluctuations in money supply in response to movements in export prices and the balance of payments. These fluctuations can generate instability in domestic economic activity and prices" [Garnaut and Baxter, 1983: 128].

The above observation with regard to Papua New Guinea seems to be in line with the "common thought that fluctuations in LDC's export earnings generate domestic instability (with the consequent welfare loss), complicate the task of planning and reduce the efficiency with which investment resources are used" [Massell, 1970: 618]. Moreover, "LDCs rely upon primary products or partially refined materials or minerals for the bulk of their export earnings and that it is these products which cause instability in their sectors" [Soutar, 1977: 280].

As mineral production is typically capital intensive even in developing countries, Garnaut and Clunies Ross maintain that "whatever national benefit is to be derived from them must come mainly from taxation", and suggesting that the "central task of economic management in the resource-based industries is thus to maximise the contribution that these industries make to government revenue". They proposed the RRT as an alternative form of tax system that "can secure for the government a higher proportion of the profits from each resource than most other taxation systems in any economy" [Garnaut and Clunies Ross, 1975: 272]. Their proposed tax system has generated continuing debates on this alternative form of taxation [Lloyd, 1984: 37].

6.3.2 The Mineral Resources Stabilisation Fund

The MRSF was established under the MRSF Act. The Act became operational on the 11th of September 1975. The objectives were that:

1. revenue accruing to the Government from the development of the mineral resources of Papua New Guinea is dealt with in a manner that will promote national financial stability; and

2. wide fluctuations in revenue accruing to the Government from year to year as a result of changing world market prices from minerals do not interfere with the orderly progress of the Government's development programme [Papua New Guinea Government, 1974a: 888].

Payments into the MRSF

The Act also specifies that all moneys received by the Government from or in respect of all designated mining enterprises should be paid into the Fund. These include:

1. payment of income tax and any additional tax under normal income tax provisions;

2. payment of dividend (withholding) tax and other dividends paid on stock or shares by any designated mining enterprises;
3. payments of dividends of government-owned stock, shares and debentures in any designated mining enterprises; and

4. payments of royalties.

Interest from Fund investments are also paid into the MRSF [Papua New Guinea Government, 1974a: 891]. The establishment of the MRSF was one of the most significant turning-points in Papua New Guinea's economic policy and management decisions that occurred just before political independence. The MRSF was meant to bring in a flow of funds "stabilise the use of government receipts from the copper industry over time, and automatically to sterilise much of the external payments surplus associated with exceptionally high metal prices" [Garnaut and Baxter, 1983: 122-124]. The MRSF from its inception was thus explicitly to play the macroeconomic function that the agricultural funds came to play implicitly.

The Act also provides guidelines for the amounts payable out of the Fund into government revenue each year. Under the Act "the amount to be paid into the Consolidated Revenue Fund (CRF) at any year shall be the maximum amount that, in the opinion of the Board, ... provides a flow of revenue from the designated mining enterprises to the CRF that is sustainable in terms of real purchasing power for each year of the next succeeding five years" [Papua New Guinea Government, 1974a: 891].

Having the amount to be paid into the consolidated revenue adjusted against a 5 year mineral price forecast was necessary to provide a longer time span from which to smooth out the Fund flows. Adjustment over shorter time span would lead to erratic flows.

In October 1975, the MRSF Act was amended to exclude royalties from the revenue flowing into the Fund. This became necessary in view of the undertaking by the national government to make royalties from the Bougainville mine available to the North Solomons province. This amendment to the Act has made it possible for provinces to benefit directly from mining ventures, if these ventures are established in their locality.

In February 1983, the Act was again amended to remove the restrictions which prevented the Board from lowering metal prices forecasts when metal prices fall very sharply. This was necessary to ensure that excessive fund payments are not made during periods of severe international economic recession.

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3 The MRSF is managed by a Board comprising the Secretary of Finance as Chairman, Secretary of Minerals and Energy and the Director of National Planning Office. The National Planning Office is now directly under the Ministry of Finance, thus implying that Board membership may have changed.
6.4 The Transmission of Export Instability: Some Empirical Results

6.5 Tax and Non-Tax Revenue Sources

We begin the empirical analysis on the transmission of export instability in the Papua New Guinea economy by examining the various components of revenue. In the subsequent discussion it will also be necessary to examine the effects of export instability on domestic development variables and the way export instability has been transmitted into the economy.

Components of Revenue

The macroeconomic relationship in any economy is complex, and in Papua New Guinea this is also the case. However, for purposes of exposition it is necessary to establish the essence of the components of revenue as they relate to the underlying framework of the analysis that will follow. The usual national income identity is depicted as follows:

\[ Y = C + I + G + X - M \]  

In equation (6.1) \( Y \) is the national income, \( C \) and \( G \) are private and government expenditures respectively, \( I \) is gross investment while \( X \) is exports and \( M \) is imports. This is the traditional national income identity, where \( Y \) is also the GDP.

Within this relationship other disaggregated variables make up the individual components of \( Y \). For example, the expenditure on government consumption is made up of total revenue (\( TR \)), and where there is a shortfall in internal revenue to finance government expenditure, net overseas financing (\( NOF \)) and net domestic financing (\( NDF \)) become necessary to meet this shortfall. Thus, the relationship is depicted as below.

\[ GC = TR - NOF - NDF \]  

The total revenue component of equation (6.2) comes from two major sources; the foreign grant from Australia and the internal revenue source. As Papua New Guinea relies heavily on Australia and the mining sector for these components of internal revenue, the above relationship is important. The internal revenue component of the relationship can also be characterised in the following way:

\[ TR = IR + FG \]  

The internal revenue component of equation (6.3) is also composed of company taxes, personal income taxes, indirect taxes (excise, duties, etc.), and most importantly the MRSF. Thus, for the Papua New Guinea economy the MRSF and the foreign grant from Australia are very important for government expenditure programmes.

These relationships depict the essence of a complex macroeconomic relationship.
The above equations could be extended to include the various components of the individual items, for example, the components of internal revenue are direct and indirect taxes and the MRSF. All these could be further broken down to the various individual components as in the MRSF which comprise corporate tax, dividend withholding tax and additional profits tax.

6.5.1 The Data

Annual data for key economic variables were available only for a 15-year period (1970-84). The variables included here are the major components of government revenue: domestic, direct and indirect tax revenue sources. Within the tax revenue source we have included three sub-categories: the MRSF, company tax and taxes on goods and services. The two sub-categories of taxes within the indirect tax sources are the export taxes and taxes on income from investments. The reasons for including these revenue sources are: firstly, to determine the relative movements of these variables against exports; and secondly, to find out which of these variables are the channels of transmission of export instability into the Papua New Guinea economy.

The regression results that follow are somewhat tentative as the 15-year time-series used is too short for definitive interpretations to be made. Thus, the results should serve only as points of discussions of the likely effects and transmission of export instability in the Papua New Guinea economy. In any case, for our purpose the results would indicate the relative movements of these variables against those of exports, and these are likely to be the trend even for longer periods of time. Measurement of these variables for this analysis is along the same lines as in Chapter 3 where exports and other variables are measured as deviations around trend.

6.5.2 Major Components of Revenue

Government Revenue

When deviations from trend for government revenue ($\Delta GR_t$) were regressed on those of exports ($\Delta X_t$), we find a very low $R^2$ and the t-ratio is insignificant. Equation (1) of Table 6-3 suggests that although government revenue trend deviations follow those of exports, the relationship is not highly significant. In this sense, it seems to indicate that export fluctuation is not really a significant factor in affecting government revenue fluctuation. In the case of Papua New Guinea, total government revenue originates from domestic and foreign sources. With Australia still providing a major share of the government budget, this has no doubt affected this result. We would expect, however, that when domestic revenue deviations were regressed against export trend deviations there would be a significant relationship.

Domestic Revenue
When trend deviations of domestic revenue ($\Delta DR_t$) were regressed on those of exports, we found a low $R^2$ and t-ratio significant at both the 1 and 5 percent level. The results tentatively confirm that export fluctuations are transmitted through domestic revenue rather than total revenue. But given the low $R^2$ and small sample size, these results are somewhat tentative.

### 6.5.3 Direct Tax Revenue Sources

#### Tax Revenue

Generally, domestic sources of revenue are categorised into direct and indirect tax sources. Equation (3) of Table 6-3 shows the relationship between deviations from tax revenue trend ($\Delta TR_t$) and deviations from export trend ($\Delta X_t$). This gives an $R^2$ of .23, with significant t-ratio at the 1 and 5 percent level. The result suggests that fluctuations in exports significantly affect those in tax revenue.

In the case of Papua New Guinea, sources of revenue originating from taxation comprise a relatively high proportion of the overall government revenue. Tax revenue comes from wages and salary incomes and profits, as well as from goods and services. Company tax, dividend withholding tax, excise duties and individual income tax, are the main sub-categories. As most of these categories of tax revenue sources are directly or indirectly linked to the export sector, it is not surprising to find the kind of relationship depicted in equation (3). This result suggests that tax revenue is a channel through which export instability is transmitted to the Papua New Guinea economy.

The **MRSF**

A particularly important source of government revenue originates from the MRSF. When trend deviations of MRSF flows ($\Delta MRSF_t$) were regressed on deviations from the export trend with a two-year lag, the results show a fairly high $R^2$ with a significant t-ratio at the 1 and 5 percent level. We use a two-year lag because funds from the MRSF do not flow immediately to consolidated revenue once they are paid by the mining companies to the government. These are deposited in the MRSF and drawn upon when needed for financing the government budget. The payments by mining companies are due during a tax year, thus, there is a lag of at least one year between export earnings by the mining companies and the payments to the MRSF. The positive relationship between the independent and the dependent variables suggests that export fluctuations do affect the stability in the flow of funds from the mineral sector, and that mineral revenue is a channel through which export fluctuation is transmitted to the Papua New Guinea economy.

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4 The analysis refers to the MRSF outflows to the budget each year.
Table 6-3: Export Instability and Categories of Government Revenue in Papua New Guinea.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Dependent</th>
<th>Constant</th>
<th>Independent</th>
<th>$R^2$</th>
<th>D.W.</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>$\Delta GR_t$</td>
<td>-4.90</td>
<td>.19 $\Delta X_{t-2}$</td>
<td>(.18)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) (a)</td>
<td>$\Delta DR_{t-1}$</td>
<td>-.83</td>
<td>.11 $\Delta X_t$</td>
<td>(.09)</td>
<td>.04</td>
<td>13</td>
</tr>
<tr>
<td>(b)</td>
<td>$\Delta DR_{t-1}$</td>
<td>-7.97</td>
<td>.19 $\Delta X_{t-2}$</td>
<td>(.12)</td>
<td>.11</td>
<td>12</td>
</tr>
<tr>
<td>(3) (a)</td>
<td>$\Delta TR_t$</td>
<td>-3.52</td>
<td>.10 $\Delta X_{t-2}$</td>
<td>(.06)**</td>
<td>.12</td>
<td>13</td>
</tr>
<tr>
<td>(4) (a)</td>
<td>$\Delta MRSF_t$</td>
<td>1.01</td>
<td>.08 $\Delta X_{t-2}$</td>
<td>(.03)**</td>
<td>.47</td>
<td>12</td>
</tr>
<tr>
<td>(5)</td>
<td>$\Delta CT_t$</td>
<td>.65</td>
<td>.05 $\Delta X_t$</td>
<td>(.02)**</td>
<td>.32</td>
<td>15</td>
</tr>
<tr>
<td>(6)</td>
<td>$\Delta TGS_t$</td>
<td>-.002</td>
<td>.02 $\Delta X_{t-1}$</td>
<td>(.10)**</td>
<td>.32</td>
<td>15</td>
</tr>
<tr>
<td>(7)</td>
<td>$\Delta NTR_t$</td>
<td>7.45</td>
<td>.27 $\Delta X_t$</td>
<td>(.04)**</td>
<td>.10</td>
<td>14</td>
</tr>
<tr>
<td>(8)</td>
<td>$\Delta ET_t$</td>
<td>.34</td>
<td>.008 $\Delta X_t$</td>
<td>(.003)**</td>
<td>.41</td>
<td>15</td>
</tr>
<tr>
<td>(9)</td>
<td>$\Delta IY_t$</td>
<td>.67</td>
<td>.03 $\Delta X_t$</td>
<td>(.008)**</td>
<td>.48</td>
<td>15</td>
</tr>
</tbody>
</table>

Notes:
(i) The Cochrane-Orcutt autoregressive transformation was performed on all equations.
(ii) Numbers in parentheses are standard errors.
(iii) ** (significant at both 1% and 5% level); * (5% level of significance); D.W. (Durbin-Watson statistics); N (sample size); and $R^2$ (Adjusted $R^2$).

Sources:
Data from:
**Company Tax**

When trend deviations of company tax ($\Delta CT_t$) were regressed on export trend deviations with a one-year lag, there emerged a moderate $R^2$ with the t-ratio showing a 1 and 5 percent level of significance. There is a positive sign between the independent and dependent variables. This result suggests that company tax is one major channel through which export fluctuations are transmitted to the Papua New Guinea economy. This is expected, given that the majority of companies in Papua New Guinea are in some way or another associated with the export sector, so that their fluctuating export earnings affect their payments of taxes to the government.

**Taxes on Goods and Services**

Another important source of revenue originates from taxes on goods and services. When trend deviations of this variable ($\Delta TGS_t$) were regressed on those of exports, a positive relationship was obtained with a moderate $R^2$ and a significant t-ratio at both the 1 and 5 percent level as shown in equation (6). The result suggests that taxes on goods and services are another channel through which the effects of export fluctuation is transmitted to the Papua New Guinea economy.

### 6.5.4 Indirect Tax Revenue Sources

The other major source of domestic revenue originates from indirect tax sources, comprising taxes on the sale of goods and services, fees and fines, mining royalties, rent and taxes on income from investments. Most categories of indirect tax revenue sources are not directly related to the export sector, with the possible exception of mining royalties and incomes from investments. When trend deviations of indirect tax revenue were regressed on those of exports, a positive relationship was obtained as depicted in equation (7)- Table 6-3. The t-ratio is significant at both the 1 and 5 percent level. The result suggests that in general indirect tax revenue sources are affected by fluctuations in exports.

**Export Tax**

When trend deviations of export tax ($\Delta ET_t$) were regressed on export deviations, the results show a high $R^2$ with a significant t-ratio. Although export tax provides only a minor proportion of government revenue, it is another channel for the transmission of export fluctuation into the economy.

**Investment Income**

In the indirect tax revenue source of the Papua New Guinea economy, it seems that taxes on income from investments feature most prominently. Thus, in order to see the extent of the relationship between fluctuations in income from investments and export fluctuation, trend deviations of the former variable ($\Delta IY_t$) were regressed on those of the
latter ($\Delta X_t$). Equation (9) of Table 6-3 shows the relationship to be a positive one, with a high $R^2$, and significant t-tests at both the 1 and 5 percent level. The taxing of income from investments is an important channel for transmitting the effects of export fluctuations to the Papua New Guinea economy.

6.6 Conclusion

The reason for the establishment of the agricultural commodity stabilisation funds was initially primarily to stabilise income to the respective primary commodity producers. The MRSF aimed to maintain a steady flow of revenue to the government from the mineral sector and the agricultural funds also came to be used for a macroeconomic role by the Bank of Papua New Guinea.

The regression results presented in Table 6-3 give some varied, but interesting results regarding the effects of export instability on the categories of direct and indirect tax revenue sources. These results were included despite the smallness of sample sizes to see the way fluctuations in export earnings affect these variables, and to determine the various channels through which export instability is transmitted into the Papua New Guinea economy.

As far as the major categories of government revenue are concerned, we find some interesting results. When government revenue were regressed on export fluctuations (both measured as deviation around trend), the results show the same directional movements but with a low $R^2$ and an insignificant t-ratio. Nonetheless, the results suggest that government revenue is a channel of transmission of export instability.

The regression results for the domestic component of government revenue against export instability show similar results. Within the tax revenue sources, mineral revenues (via the MRSF flows as a component of government revenue) are shown to be an important channel of transmission of export instability in the Papua New Guinea economy. Given the importance that mineral revenues will have on the economy in the future, this suggests that the MRSF would have to play a key role in the stabilisation of government revenue, thereby reducing the impact of export earnings instability on the economy.
CHAPTER 7
QUANTIFYING TRADE-OFFS IN MINERAL TAXATION POLICY

7.1 Introduction

The Bougainville mine has had a very important impact on government revenue, but mineral revenues are highly influenced by world mineral prices. During periods of high mineral prices, the revenues are fairly stable and may indeed rise; but with the downturn in mineral prices the opposite is usually true. Because of these swings of revenues derived from mining, the establishment of the MRSF was seen as necessary to stabilise revenue flows into the budget. Treadgold (1971) had recognised the potentially destabilizing effects the Bougainville mine could have on government revenue and sounded an appropriate warning.

Papua New Guinea aroused a great deal of interest with its mineral resources and its widely publicised innovative fiscal measures in the form of a resource rent or additional profits tax. This measure was introduced when the Bougainville Copper Agreement was renegotiated in 1974. The renegotiated Bougainville Agreement subsequently laid the foundation for the Ok Tedi Agreement. Some major differences exist between the two mining agreements in relation to the methods of assessing taxable income subject to the APT. The differences will be apparent in the applications of the model in the later sections of this chapter.

This chapter focuses on the Bougainville mine operating under the 1974 Agreement, and two proposed mines to operate within the framework of the General Mining Legislation (1978). The General Mining Legislation follows the basic fiscal framework of the Ok Tedi Agreement (1976). Ok Tedi is left out of the analysis because of lack of adequate data. Lihir, another proposed mine in the New Ireland province is left out for the same reason.

We focus on Bougainville because of its historical data, and also to evaluate its taxation impact due to its unique rent tax formulation. It was the first mine in Papua New Guinea to have been subjected to the APT in 1974. Misima mine has been chosen because it is likely to be the next project to be developed in 1989. It is also a marginal project in comparison to Bougainville and Ok Tedi. For this reason, the taxation analysis
derived from it will determine some of the ways the company tax, royalty and rent taxes affect a marginal mine. Porgera mine will be a relatively large mining project. Its inclusion in the analysis will determine the impact of mining taxation on a large project under the General Mining Legislation.

7.2 Assumptions and Analytical Framework

This section of the study summarises the underlying framework and the assumptions under which the Bougainville, Misima and Porgera mines are evaluated. Because of space restrictions, most of the equations necessary for this evaluation are not included here, but are provided in Appendix D. These equations provide the model on which the projects' evaluations are based. Each mineral project has specific characteristics; thus, the underlying performance is likely to differ in detail. For example, ore production and concentrate exports differ from one mine to the other based on the size of the mine and the quality of the ore. Basic mine characteristics and the fiscal regimes it operates under will be discussed in later sections.

For analyses, the mines are grouped into two main parts: the first part deals with the historical analysis of the Bougainville project, and the second part deals with two prospective mines: Misima and Porgera. Ok Tedi, not yet in full production would fall between these two cases but has not been studied for lack of data.

The Bougainville mine is the only one in Papua New Guinea to mine three minerals: copper, gold and silver. Ok Tedi will only be mining gold and copper. Gold mining is presently underway at Ok Tedi, with the mining of copper to come on stream around mid-1987. The other mining projects now proposed will be mining gold and silver: they include Lihir (New Ireland Province), Pogera (Enga Province), and Misima (Milne Bay Province).

The analyses that follow use the underlying assumptions and data in an attempt to examine the impact of tax policy in the mineral sector in Papua New Guinea. We use a mathematical model incorporating tax, income and investment methods of determining rates of return to the government and mining companies, on a number of mines in Papua New Guinea. Because of space and data restrictions, the following analysis is based on three mines, Bougainville, Misima and Pogera. The first has been in operation since 1972 while the other two are being proposed to start in the late 1980s or early 1990s. Misima is a marginal project, thus, its inclusion in the analysis is itself interesting in as far as determining the extent to which mining tax policy in Papua New Guinea affects this sort of mine. Pogera, on the other hand, is a much bigger mine than Bougainville or Ok Tedi.
7.2.1 Operating Cost and Depreciation

For the Bougainville case, operating costs as reported by Bougainville Copper Limited are used. The company only reports the total operating costs incurred each year. For the analysis, operating costs for the production of each mineral type were necessary. It was assumed that the share of costs was proportional to the share of sales in each year. Unit mining costs for the Bougainville mine were derived as indicated in Table E-2 | Appendix E |. Unit operating costs for the Misima and Porgera mining projects were calculated in a slightly different manner | see Table E-4, Appendix E |

Two methods of calculating depreciation are commonly used in an analysis of this kind; the straight-line and declining balance methods. In a straight-line method, a fixed rate of the total capital expenditure is allowed as a tax deduction each year over a specified period. In the declining balance method, the specified rate applies to the undepreciated capital investment remaining in each year.

Accelerated Depreciation and Taxable Income

Pintz (1984, p.188) illustrated the use of the accelerated depreciation option under the General Mining Legislation in the Ok Tedi case. This option only applies when the cash inflow to the project (i.e. the sum of taxable income plus tax depreciation less income tax) is less than 25 per cent of 'initial capital expenditure'. In this case, initial capital expenditure is investment to the end of the tax year for which additional deductions are sought. This accelerated depreciation may take place to the extent that tax payments are reduced to the point where inflows reach 25 per cent of initial investment, but may not be accelerated so that a tax loss is created. The accelerated depreciation provisions are based on a tax payable calculation.

Because of the problems of determining 'initial capital expenditure' the analysis on Misima and Porgera is based on a simple assumption regarding accelerated depreciation. It assumes that in the investment recovery period no APT payments are made. During the investment recovery period, tax depreciation is allowed, thereafter any positive cash flow to the mining company is subject to the company tax and APT.\(^1\) Given that the tax and APT payments are paid whenever the cash flow is positive under the General Mining Legislation compared to the Bougainville Agreement, this assumption is adequate for this kind of analysis.

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\(^1\) The term tax depreciation refers to capital depreciation allowed as tax deduction.
7.2.2 Loans and Interest Payments by Company and Government

Loans and Payments by Company

Most mining projects are not entirely financed by internal company funds; a major proportion of investment finance is borrowed from international capital markets, mainly through bank loan syndications. In mineral projects, it is common to find a debt to equity ratio ranging from 2:1, 3:1 or even around 4:1. The Bougainville project's debt to equity ratio was 3:1; that is, 75 per cent was borrowed from banks in the United States and Australia and two trading companies in Japan (Wilshire, 1974: 62). The other 25 per cent was financed from internal company funds. In the absence of accurate information about interest rates, duration and other fees and charges on which loans are obtained, assumptions regarding the cost of loans was necessary for the analysis. It was thus assumed that the rates used for repayments of loans by the mining companies were 12 per cent, while for the government they were 10 per cent.

Loans and Payments by Government

Just as mining companies borrow funds to invest in a mining project, it is also assumed in this analysis that the Papua New Guinea government borrowed or will borrow to finance its share in the mining projects. The government has a 20 per cent share in the Bougainville and Ok Tedi projects, while some uncertainties remain with regard to the government's share in other projects. It will be assumed that the government is likely to have a 30 per cent equity in Pogera and no equity at all in Misima. Governments of developing countries usually desire to have a direct share in resource projects in their countries to share in the mineral rents, be assured of influence on the rate of development of the resource and have insight into the companies' accounts to avoid transfer pricing at other than arms' length, and ensure the proper payment of taxes. This is also true in Papua New Guinea.

Given limitations of funds for development programmes, funds required for investment projects such as Bougainville and Ok Tedi have been borrowed from the international capital market. In the case of Ok Tedi, the share of Government's investment was financed by the mining company with the provision for repayment to the company at internationally accepted loan prices (of interest, time terms, etc.). In the Bougainville project, the original Papua New Guinea government investment share was financed by an Australian grant. Where investment is being financed from loans, loan repayments and interests have to be accounted for in cash flow analyses.

Interest Payments on Loans by Government

The last 30 years have seen a shift in the ownership and funding of mineral projects in developing countries. Most developing countries wish to have an equity share or total equity ownership in mineral developments to establish control over the rents earned by
the project. This involves control over such issues as the rate of extraction and transfer pricing policies. Such equity funding (and associated loan funding) is generally financed by government borrowing. Developing country governments frequently have access to loans on terms which are below market levels through the multilateral development banks. Even if this is not the case, government borrowing is often at a lower rate than market borrowing by private firms. Mineral projects are, moreover, often favoured because of their foreign exchange earning capacity by the development banks as well as by the private markets. Government investment in minerals is usually highly leveraged, even though there may be a considerable equity component.

Interest Payments on Loans by Company

Corporations also tend to prefer highly leveraged mineral investment. They want to avoid the risks of nationalisation. Moreover, in taxation and after tax profit term loans are preferable to equity, particularly in a mine with a high value mineral ‘cap’. Equity earns dividends which are taxable. The repayment of loans is operating cost, which is tax deductible. A mine that has high earnings for the first few years can be highly leveraged. The corporation then has high repayments in early years of the mine, but then has a major asset for little equity investment and can afford to operate at relatively high costs/loans prices in the life of the mine. Large mineral capacities generally also have ready access to the capital markets at relatively low terms.

7.2.3 Methods of Assessing Investment Projects

A number of ways of assessing investment projects has been widely discussed in the accounting and investment literature. They fall into two main groups: nondiscounted and discounted cash flow techniques.

An example of the nondiscounted cash flow method is the ‘payback period’. This is the simplest way of determining whether to accept or reject an investment project proposal. The payback period refers to the number of years needed in order to recover the initial investment outlay. While this method is simple, it ignores accounting profits and relies solely on after-tax returns. For the investor to accept the investment proposal, the payback period must be less than or the same as that of the investor’s. This method does not consider the time value of money as in the discounted cash flow methods. Although it is limited in its usefulness on its own, it is more practical when used in conjunction with the discounted cash flow methods. Most current financial appraisal literature uses either the internal rate of return (IRR) or the net present value (NPV). Both consider the time value of money and its relevance in the overall exercise of assessing an investment project.

The Internal Rate of Return

The IRR is used in project appraisal to determine "the discount rate that equates
the total discounted income with the total discounted costs of a project over the project life" [Johnson, 1982: 456]. Essentially the IRR attempts to determine the rate of return that the project will earn. The IRR is defined as "the discount rate that equates the present value of the project’s future net cash flows with the project’s initial cash outlay" [Petty, et. al., 1982: 277]. The mathematical definition of the IRR can be shown in the following way:

\[ IO = \sum_{t=1}^{n} \frac{(ACF_t)}{(1 + IRR)^t} \]

where \( ACF_t \) is the annual after-tax cash flow in time period \( t \) (the ACF can take on a negative or positive value); \( IO \) is the initial cash outlay and \( n \) is the life of the project in years.

The concept of IRR can be explained as follows. Assume that an initial investment outlay was placed in a bank where it earned a rate of return (RR) equal to the IRR. At the end of the first year, we could withdraw an amount \( ACF_1 \) and in the second year \( ACF_2 \) and so forth. By the end of the nth year when all ACF has been withdrawn, the funds would have been exhausted; thus, the fund’s IRR is simply the rate of return the fund is able to earn. In this context, a project’s IRR is the rate of return that the project earns from an initial investment outlay. In general, the decision criterion for project evaluation may be simply put as follows:

Accept if \( \text{IRR} > \text{required rate of return} \)

Reject if \( \text{IRR} < \text{required rate of return} \)

Mining companies determine the required rate of return for an investment project by reference to their various investments, project risk, country risk, etc.. Given these factors, the rate of return for any one project is appropriately adjusted for risk. That is, the company knows the rate for which it would be prepared to undertake the investment. If the project fails to give this rate of return then the company will not invest; if the cash flow analysis shows a higher rate of return than the company’s predetermined rate the investment will take place.

The Net Present Value

Amongst the discounted cash flow methods of evaluating projects, the most commonly used is the net present value (NPV) approach. The NPV of an investment project is defined as "the present value of its annual net cash flows after tax less the investment outlay" [Petty, et. al., 1982: 272]. This can be expressed mathematically as follows:

\[ NPV = \sum_{t=1}^{n} \frac{(ACF_t)}{(1 + R)^t} - IO \]
where $ACF_t$ is the annual cash flow in time period $t$ (which can be either positive or negative), $R$ is the rate of discount rate or the rate of return, $IO$ the initial investment outlay and $n$ is the project's life in years.

Put simply, the project's NPV represents the absolute value of an investment in terms of today's value. Discounting cash flows back to the present is necessary since we are interested in the difference between the present value of the annual cash flows and the initial investment outlay of the project. It is the difference between the present value of the annual cash flows and the initial investment outlay which determines the net value of the investment expressed in today's value. The decision criteria are as follows:

Accept if $NPV > 0.0$
Reject if $NPV < 0.0$

The project will be accepted if the $NPV$ is positive, and rejected if the $NPV$ is negative. If the $NPV$ is equal to zero, then the investor is indifferent whether to accept or reject the investment project. This means that if companies' cash flow analysis shows the project's IRR to be at the level company requires as sufficient for investment then the company will go ahead and invest. If the IRR is below expected levels, then there is no incentive to undertake the investment.

Sometimes both the IRR and NPV are used together to assess an investment project. As the NPV can also take on a negative value, the IRR therefore helps as the selection criterion. An investment project with a higher IRR and NPV relative to similar projects would be most preferred if both methods were used as decision criterion. The analyses that follow would illustrate the usage of both approaches.

7.3 Bougainville Mining Project: A Historical Analysis

In the case of this analysis, it is necessary to evaluate cash flows from the Bougainville Copper project given its historical data. As would be obvious later, some assumptions are also used in the analysis where insufficient data are available. The present analyses attempt to put forward another alternative way of taxing the project, given the historical data on the project. It is an exercise in the analysis of the RRT or the APT as was proposed to be used on the Bougainville project but failed to be wholly applied due to resistance from the mining company. The 1974 Bougainville Mining Agreement was conceived along the lines of the new formula [ see Appendix C.1 ], the analysis therefore uses this basic formula for calculating taxable income which becomes subject to APT.

Concentrate Prices and Sales

The Bougainville price and quantity data used are taken from the Bougainville
Copper Limited's Annual Reports.\textsuperscript{2} Given the mineral prices and concentrate sales, we therefore derived concentrate mineral prices \cite{see Table E-1, Appendix E}. The principal reason for deriving and using the concentrate prices is because Bougainville Copper Ltd. sells concentrate rather than metal. Concentrate prices are generally lower than pure metal prices in mineral markets. If the latter prices were used for analytical purposes, an unrealistic sale values that would have inflated cash flows would have been derived.

The average contribution to total sales value by each of the minerals produced at the Bougainville mine from 1972 to 1984 period was silver (2 per cent), gold (23 per cent) and copper (75 per cent). For this analysis, allowances are made for cash flow analysis resulting from the sales of copper and gold concentrates.\textsuperscript{3} The annual sales value is derived by multiplying the quantities of copper concentrates produced (in thousands of metric tonnes) and gold concentrate (gold dore') produced by their respective concentrate metal prices \cite{see Table E-1, Appendix E}.

\subsection*{7.3.1 Calculating Taxable Income and APT}

The calculation of APT in the Bougainville analysis differs slightly from the 1974 Agreement formulation. As shown in the formulae (Appendix C), in order to calculate the taxable income to be subject to APT, not only must the taxable income be positive, but it requires other variables such as K (opening capital stock), C (closing capital stock), E (capital expenditure), R (depreciation and costs of disposed capital equipment), and the exchange rates for the kina against the US dollar. All these variables must be available for the construction of taxable income that is subject to APT.

In the absence of some of the variables required for APT calculation, the present analysis relies on somewhat differently based estimates (see equations D.43 to D.48).

Instead of N of the original APT formula \cite{see Appendix C.1}, the present analysis calculates 'capital adjustment' (CAPADJ). This capital adjustment is derived from the initial investment (CAPITAL) multiplied by the company proportion which is the total less the government share \((1.0 - GK)\). These are multiplied by the exchange rates expressed in terms of kina per US dollar to adjust for any exchange rate fluctuations that may have arisen over the current tax year and last year. Following Wilson \cite{1984}, the capital base for calculating APT is derived by adjusting the 'capital adjustment' by the threshold rate, and this then is divided by the proportion of company tax rate applied \((1.0 - INCTAX)\). This is then multiplied by the proportion after adjusting for company

\textsuperscript{2}The bulk of this information for the historical analysis came from the company's 1984 Annual Report.

\textsuperscript{3}Silver is left out of the analysis mainly because its contribution to total revenue is expected to be negligible.
tax and APT (i.e. 70% - INCTAX). 4

Adjusting for exchange rate fluctuations

An exchange rate adjustment is necessary because sales and other financial contracts in the Bougainville Copper Agreement are denominated in the US dollar while the APT is paid in kina. If exchange rate adjustments were not included in the formula, movements in the US dollar vis-a-vis the kina, or vice versa, would affect the tax estimations. For example, a devaluation in the kina against the US dollar means a fall in the buying power of the kina in terms of the dollar. Thus, taxes collected from the mining companies would be less than if a devaluation of the kina had not occurred. If the kina appreciated, the opposite would be true. The company would be paying higher kina taxes, since the kina would be worth more than the US dollar.

APT Calculation

In the 1974 Bougainville Agreement, any amount that is over 15 per cent of 'additional investment' or 'capital base' is subject to APT. In this case, the APT threshold rate is 15 per cent and the APT tax rate is 35 per cent. The present analysis similarly adjusts for taxable income subject to APT.

For the present analysis, we use the APT threshold rate (APTPRF) of 15 per cent. It was necessary to first calculate capital adjustment (CAPADJ) adjusted for the exchange rate (kina/$US) movements (EXRATE). Capital adjustment refers to additional expenditure undertaken each year on the mine by the mining company. This additional expenditure is based on the assumption that over the life of the project, the expenditure on the mine will add up as the proportion of capital provided by the company in the initial period (i.e. CAPTAL x (1.0 - GK)). GK is the share of capital provided by the government in the project. This assumption may not be realistic, but given the lack of data on additional expenditures on the mine, it is the best that can be made.

Following Wilson (1984) the additional capital base (ACB) is derived by multiplying CAPADJ by APTPRF with the necessary tax adjustments. The APT is only applied when taxable income for APT calculation (APTCAL) is over 15 per cent of CAPADJ (i.e. CAPADJ + ACB). The amount in excess of 15 per cent of CAPADJ is the net capital base (NCB) (i.e. ACB - APTCAL). If NCB is greater than ACB, this implies that ACB is in excess of 15 per cent of CAPADJ and therefore APT is due. If NCB is less than ACB (i.e. less than 15 per cent of CAPADJ) then no APT is paid (see equations D.43 to D.48, Appendix D).

4 In Wilson's method of calculating the 'capital base', N = 390 x 0.15 divided by (1 - 0.3333) x (0.7 - 0.3333), see Wilson (1984, p.42).
7.3.2 Risk Analysis for the Bougainville Case

Chapters 3 and 4 have dealt with some aspects of risk in mineral projects. Various types of risks are here analysed further for the Bougainville mine.

Risk may be defined in terms of the variability of possible outcomes from a given investment... that risk is measured not only in terms of losses but also in terms of uncertainty [Block and Hirt, 1984: 341].

Given the existence of risk, risk aversion is inherent in mineral investment. Financial theory assumes that most investors and managers are risk-averse. Risk aversion refers to the preference for relative certainty over uncertainty. For investment undertaken in risky conditions, investors would generally require a higher expected value or return than those undertaken under less risky conditions.

Measures of risk

Risk may be measured in various ways. For the present analysis we concentrate on commonly used measures; namely, standard deviation and the coefficient of variation.

A company must carefully assess the risks involved before undertaking the investment. In the present analysis, we examine a number of scenarios regarding cash flows to the government and company given different mining taxation policies. The main question we want to deal with is: what are the risks involved regarding cash flows to the government and company under existing mineral tax policy compared to alternative policies? That is, what type of tax policy creates risk for the government and the company?

Risk in Government Cash Flows

We examine different tax policy scenarios as they apply to Bougainville. The method of calculating taxable income for APT has already been spelt out. In this case, the analysis will focus on government revenue cash flows and the risks involved due to changing rates of tax and APT. The argument is that the higher the rate of APT the greater the risk as the APT is likely to deter foreign investment in the mining sector. The risk measure used is the coefficient of variation which is derived by dividing the standard deviation (ρ) by the mean (μ). Under the existing tax policy with royalty (1.25%), company tax (35%), APT threshold (15%) and APT (35%), the scenario is said to be preferable for mining firms to invest in the mining sector. Since the coefficient of variation measures dispersion around the expected mean value, this suggests that the larger the coefficient the greater the dispersion, and therefore the greater the risk.

Case A: APT = 0, Tax = 70%

The first scenario depicts a royalty rate of (1.25%), corporate tax (70%), and no APT applied to profits. The results give a mean government cash flow of K254.7m accruing solely from royalty and tax payments. The risk measured as the coefficient of variation or dispersion around this mean is .169.
Table 7-1: Bougainville Mining Project: Cash Flow and Tax Policy

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<tr>
<th>Case</th>
<th>Royalty (%)</th>
<th>Inctax (%)</th>
<th>APT (%)</th>
<th>GCF Mean (Km)</th>
<th>Std</th>
<th>CV</th>
<th>GNPV Mean (Km)</th>
<th>Std</th>
<th>CV</th>
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<th>IRR (%)</th>
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Notes:

(i) APT is calculated as (70% - Inctax) - see text for further explanation.
(ii) Std (standard deviation); CV (coefficient of variation).
(iii) GCF (Government Cash Flow); GNPV (Government Net Present Value); CCF (Company Cash Flow).
(iv) CEPV (Company Equity Present Value); IRR (Internal Rate of Return); CECF (Company Equity Cash Flow) and TCCF (Total Company Cash Flow).
Case B: APT = 20%, Tax = 50%

The second scenario depicts an increase in APT by 20 percent from Case A, and 50 percent tax. The results show a decrease in the mean cash flow as well as in risk to the government. These are respectively K201.9m and .167 as shown in Case B | Table 7-1 |

Case C: APT = 35%, Tax = 35%

The third scenario depicts the existing mining taxation policy in Papua New Guinea. Within that policy framework, royalty is (1.25%), tax (35%), and APT (35%). In this scenario, the mean government cash flow is K162.3m while the coefficient of variation is .165; both have been reduced from the previous scenarios. Again the higher APT has led to a reduction in mean cash flow associated with a lower degree of risk.

Case D: APT = 40%, Tax = 30%

The fourth scenario depicts an increase in APT to 40 percent, and 30 percent tax. This increase in the APT rate gives a mean cash flow of K152.2m with a coefficient of variation of .163. This scenario represents a lower degree of risk relative to earlier cases.

Case E: APT = 50%, Tax = 20%

Given existing economic conditions, the fifth scenario represents an extreme taxation policy where an APT rate of 50% applies to profits, this rate is highly unlikely to be applied in any mining projects in Papua New Guinea. If this APT rate were to apply with royalty and corporate tax remaining at their existing levels, the mean government cash flow is now K132.9m with a coefficient of variation of .187. Thus, this last case also shows that a higher APT rate leads to higher degree of risk facing the government.

Case F: APT = 70%, Tax = 0%

The sixth scenario is also unlikely but included here for purposes of comparison. We find that when no tax at all is imposed, and if the government relies solely on APT for generating revenues, then this gives the least mean cash flow of K114m with the highest risk (CV) of .274. Obviously, this scenario is not likely to be preferred by the government. For the company, however, this would be the most preferred policy scenario as it gives the highest mean cash flow of K210.4m, and therefore the least risk.

What are the trade-offs?

How do we explain this greater risk in revenue flows to the government? It is necessary to reflect on our earlier discussions about conflicting objectives of the resource-owners (usually a government), and the resource-investor (usually a foreign firm). The primary objective of the resource-owner is to maximize foreign exchange and fiscal receipts, while that of the resource-investor is to maximize profits after all tax has been paid.

A government must employ an optimal set of fiscal policies to maximize its fiscal
receipts. However, in formulating such a set of optimal fiscal policies, behaviour of the
resource-investor must be considered, for the policies will affect investment decisions. For
example, an APT rate of 35 per cent means a relatively higher share of the profits made
by the mining company will be paid to the government than without an APT. The
company will have to forego that same amount in profits for its share-holders. The mining
firms would like to keep the tax and APT rates as low as possible while the government
would prefer the opposite.

In practise in the mining agreements presently in use in Papua New Guinea, the
company income tax and the APT go hand-in-hand as part of an integrated tax policy
package. In the Bougainville and Ok Tedi mining projects, the APT rates are derived
from the company tax rates when calculating additional profits subject to additional tax
see Appendix C]. It also makes no economic sense to discuss the APT without the
company income tax in theory. The APT is the mechanism of capturing what the normal
company tax does not capture, that is the surplus profits.

The historical analysis of Bougainville shows that the application of one tax alone
does not necessarily minimise risk with respect to cash flows to the government. Indeed,
as Case D suggests, the combination of company tax (30%), and APT (40%) give the
least risky cash flows to the government in terms of coefficient of variation of mean cash
flows. Relying on the company tax alone to capture the revenues from mining does not
necessarily imply less risk in obtaining the mean income. A combination of the company
tax and APT rates seems to be the optimal tax policy.

Risk in Company Cash Flows

As far as the company is concerned, we find that an increase in the APT does not
necessarily lead to greater risk to company cash flows. It is the company income tax rate
which leads to greater risk around a mean income to the company. As Case A suggests,
applying the maximum tax rate of 70 per cent corresponds to a greater risk in company
cash flows around the mean compared to Case E of 20 per cent tax rate. The increase of
the APT rate from 0 per cent (Case A) to 70 per cent (Case F) does not lead to higher
risk in company cash flows. Thus, in Case F, for example, there is less uncertainty or risk
when no tax at all is applied to the mining company operations. Obviously, this would be
the most preferred position for the mining company; that is, the less tax it pays the
better. For the government, however, this would not be its most preferred position as it
would be receiving revenue from the mining operations only when super-normal profits
are earned. Its most preferred position would be where it could receive the optimal
revenue from charging an optimal tax rate or a combination of tax and APT rates.

But given that the mining company would prefer less tax than more, this means
that the government has to set tax rates which are ‘optimal’ also in the sense that they
do not discourage further foreign investment from taking place in the mining sector. The government also has to earn its share of the income from the mine so that it must charge a reasonable tax on the activities of the mining firm. The conflicting objectives of the government and the investor lead to trade-offs. The mining company cannot possibly operate without paying any taxes, and the government cannot possibly charge maximum tax rates to bring in maximum revenues. A compromise has to be reached between the two parties. The government has to accept less revenue than it would otherwise prefer as a trade-off for future or continued foreign investment; while the mining firm trades off less income for relatively higher tax rates than it would prefer. These trade-offs are important for both parties.

7.4 Applications of the General Mining Legislation

In order to discuss the essential features of the General Mining Legislation in Papua New Guinea, it is necessary to examine the Ok Tedi Agreement, as the former stems from the latter. The only major differences are to do with the threshold rate used in calculating taxable income to be subject to APT. In the following section, we briefly discuss the basic features of the Ok Tedi Agreement which would help us understand the framework of the General Mining Legislation.

Fiscal Provisions

The Ok Tedi tax provisions allow for accelerated depreciation (25%), company income tax (35%), dividend withholding tax (15%), and discounted cash flow (20%). The Papua New Guinea government is also entitled to a royalty of 1.25% of the free on board value of production of the mine. This amount is passed on to the province in which the mineral is mined.

The foundations of the fiscal provisions are based on the RRT as initially proposed by Garnaut and Clunies Ross (1975, 1977 and 1979). This tax system was based on the perceived behaviour of private investors in mining ventures in contrast to host government’s decisions on the mining of these resources.

In the Ok Tedi Agreement, the RRT, later renamed the APT "was combined with Papua New Guinea’s normal company profits tax system" to form the new fiscal arrangements for the Ok Tedi mine (Pintz, 1984: 65).

While a mining agreement gives the investor the right to mine an ore body, the government expects in return a firm commitment to mine development within a specified time period. That right might be withdrawn by the host government if no such commitment or other violations of the agreement is evident. The major issues in mining contracts deal with ownership, income and taxation policies.

Equity participation by the government under the General Mining Agreement
allows for up to 30 per cent in comparison to Bougainville (20%) and Ok Tedi (20%). The issues dealing with government participation in a major investment in mining are important since considerable risk is involved. In this light, the government would need to address the questions of whether or not to be partners, and what sorts of advantages and disadvantages are involved. For company income tax, the General Regime allows for 48 per cent maximum rate to be applied to non-Papua New Guinea incorporated companies, while for domestically incorporated companies this is 35 per cent as in the Ok Tedi and Bougainville Agreements.

The Income Tax (Mining and Petroleum) Act 1978, provides for special taxation provisions similar to those of Ok Tedi. In the Ok Tedi case, the mining company chooses the APT threshold rate (or accumulation rate) of either 20 per cent or the US AAA bond rate plus 10 per cent, whereas in the General Regime the optional rate is replaced by the US Prime Rate plus 12 per cent.

The dividend withholding tax (DWT) in the General Regime is 17 per cent while for Ok Tedi it is 15 per cent. Normal import duties apply to both regimes, with optional straight-line accelerated depreciation allowances. In the case of Ok Tedi, accelerated depreciation applies if the after-tax cash flow is less than 25 per cent of initial capital outlays, while in the General Regime, this is the lesser of 5 years during exploration and the lesser of 10 years during mine development.

In the investment analysis, the tax formulation for all future mines in Papua New Guinea will be based on the General Mining Regime. It was perceived to be important for mining companies to know the mining regimes they face: the General Mining Regime was hence introduced. It provides the precise terms under which the mining companies will operate. Nevertheless, it is expected that each mining project will be negotiated on an individual basis.

The APT Calculation

The APT formulation in the General Mining Legislation is substantially different from the Bougainville case. Under the General Regime, the net losses are accumulated to the next tax year using a threshold rate which is deemed to reflect the supply price of investment. These net losses are adjusted against the positive net cash receipts. The APT is paid in any year in which the net cash receipts (i.e. returns after tax) are positive.

If the cash flow for APT calculation (CFAPT) is negative then the accumulation mechanism is activated. Equation (D.49) shows that whenever CFAPT is negative in the current tax year, this is adjusted against CFAPT in the next tax year (i.e. ACFAPT + CFAPT). The accumulated CFAPT (ACFAPT) is further adjusted by the appropriate threshold rate (APTPRF) giving rise to the amount for APT adjustment (APTADJ). Taking into account the movements of the kina against the US dollar (EXRATE) result
in additional profits adjustment (APADJ) base. As long as APADJ is negative the accumulation continues to the next year and no APT is due. Whenever CFAPT is positive, the APT is paid [see equations D.49 - D.53, Appendix D].

7.4.1 Misima Mining Project: Tax Policy and Risk Analysis

The Misima Mining project is to be situated in the island of Misima in the Milne Bay Province. There are suggestions that the project is commercially viable given sustainable mineral prices and some tax concessions from the Papua New Guinea government. An analysis of the cash flow of the project in later sections of this study will attempt to portray some features of the project. The project is likely to begin production in the later part of the 1989 if the Papua New Guinea government is satisfied with the package offered by the investors.

The Misima project will mine gold and silver. Present indications have put the project life to about 12 years, with 2 years of construction.5 The discovery of gold in Misima is not new, alluvial gold mining began there in the early 1960s, thus, it was one of the first discoveries of gold in Papua New Guinea [see Daniel. 1985: 1]. The project is a joint venture between Mt. Isa Mines Ltd (an Australian mining company) and Placer (PNG) Ltd., a subsidiary of Placer Development Ltd (a Canadian mining firm). The parent Canadian mining company through its subsidiary has a 50 per cent share in the Misima project.

At the initial stage of exploration, the estimated ore reserve at Misima was 52 million metric tonnes with 1.5-2 grams per tonne of gold, and 16.1 grams per tonne of silver.6 The Misima project is based on a relatively small gold deposit, so that by the standards of mines now being developed it is a relatively small project. The smallness of the deposit is, indeed, the reason why it was not developed earlier. However, eventually the other factors in the evaluation of the viability of the deposits - the costs of developing the project, financing costs, the availability of appropriate technology, silver and gold prices - led to a positive conclusion. New manual mining technology, in particular, markedly reduced costs. The maintenance or improvement of present silver and gold prices would make the project even more attractive.

At silver and gold prices around $US7 and $400 per ounce respectively, the Misima project is a marginal mining venture because of its size. The Misima project is fortunately favourably situated on a small island, thus, it is much more easily accessible than Ok Tedi or Bougainville which are both located in high mountains and in rough terrain. The

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5 The cash flow analyses only take into account the 10 years of production.
project costs for Ok Tedi have doubled since development began because of the roughness of its location.

The following analysis can, of course, only examine the likely outcome of the exploitation of the Misima mine in tax terms. The data and assumptions are provided in Appendices D and E. We examine the probabilities of achieving certain IRR on total and equity cash flows to the company, government and company present values, and the project’s IRR under different tax policy scenarios. It must be emphasised that the APT as applied in the mining sector in Papua New Guinea must not be isolated from the company tax and royalty payments. The APT is an integral part of the company tax as shown in the APT formulation for Ok Tedi and Bougainville [see Appendices C.1 and C.2].

**IRR on Total Company Cash Flows**

Table 7-2 presents five cases for the expected IRR on total company cash flows. The first scenario where an APT rate of 70% is imposed with no tax, the probability of company IRR being less than 5% is 59 per cent, for the IRR range between 5% to 10% the probability is 36 per cent, and between 10% to 15% the probability is 5 per cent. Under this scenario, the company only pays the APT and no tax so that its mean IRR would be lowest as shown with the highest risk (CV) or variation around this mean. As the APT rates are decreased, as shown in Cases B to D, we find that the IRR range moves upwards.

Case D with a tax rate of 50% and an APT rate of 20% gives the least risky policy option. Within this tax option, the expected IRR falls in the middle ranges of between 5% to 15%. The probabilities of earning an IRR between 5% to 10% is 31 per cent, while for an IRR between 10% to 15%, this is 48 per cent.

The extreme policy option of Case E with a tax rate of 70 per cent results in the highest mean company IRR range with a corresponding higher risk compared to Case D.

By merely examining the mean, standard deviation and coefficient of variation (CV) of the company cash flow IRR, it is obvious that increasing the APT rate does lower the mean IRR. The risk analysis as indicated by the coefficient of variation shows that an APT rate of 20 and a 50 per cent tax is associated with the least risky option.

**Company Equity Present Value**

The company’s ideal position would be Case A where the probability of earning K150m or above is 96 per cent. But this scenario is the least preferred by the government.

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7 Because it is assumed that there are no loan requirements for this project, the results for the company equity cash flows are the same as those on company total cash flows.

8 Coefficient of variation is the standard deviation divided by the mean.
Table 7-2: Misima Mining Project: Company IRR and Tax Policy

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Table 7-3: Misima Mining Project: Company Equity Present Value and Tax Policy

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</table>
because it receives the least revenue. Thus, the government would like to be somewhere in the vicinity of Cases B to D. However, Case E would be unfavourable to the company, and therefore cannot be considered. The company would probably prefer Case C where its mean present value is higher than in Case D. But given that the government would prefer to be at Case E where high tax revenues results from high tax rates, this may mean that the parties may eventually settle at Case C. The coefficient of variation shows that Case C is the least risky given the conflicting objectives of the company and the government (Table 7-3).

**Government Net Present Value**

Cases A and E again portray the two extreme cases where neither party would allow the other to settle. The reason for the company rejecting Case E is given by the probabilities of the government earning between K150m or above being 100 per cent. The government is also likely to reject Case A where the probability of earning less than K50m is 100 per cent (Table 7-4).

For the government, Case E would be the most preferred option since it gives the highest mean. Its least tax policy option would be Case A with the lowest mean and therefore lowest risk. Case A depicts no income tax with a maximum APT rate of 70%.

The mean government net present value under these five tax policy alternatives increase as the tax and APT rates increase. However, with a combination of tax and APT rates at 35% as depicted in Case C, this gives the optimal tax policy for the government. But given the constraints of company willingness to invest in the mining sector, the host government can only settle at a point such as Case C where it foregoes a higher expected mean present value using a lower tax rate, and therefore inducing the company to undertake investment in the sector.

**The APT and Marginal Projects**

Figure 7.1 illustrates diagramatically the effects of a combination of company tax and APT rates on IRR risk to company. On the horizontal axis is the company tax rate and the APT rate, where the latter is calculated as (70% - Inctax). Tax is the company tax rate. On the vertical axis is the IRR risk to the company derived from Table 7.2. With the use of the maximum APT rate of 70% and no company tax, this represents the highest risk level in the Misima project. Raising the company tax rates and lowering the APT rates by moving to the right along the horizontal axis, the degree of risk falls until it reaches its minimum point at a tax rate of 35 per cent and 35 per cent APT rate, after which point the risk level rises again. The interesting point to note is that at higher rates of APT (towards the left of 35 per cent tax on the horizontal axis), the level of risk is quite high for the company's IRR. This suggests that the application of APT, and indeed, increasing its rate for a marginal project such as Misima creates more risk for the
Table 7-4: Misima Mining Project: Government Net Present Value and Tax Policy

<table>
<thead>
<tr>
<th>Case</th>
<th>Royalty (%)</th>
<th>Inctax (%)</th>
<th>APT (%)</th>
<th>Net Present Value Range (Km)</th>
<th>Probability (%)</th>
</tr>
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<tr>
<td></td>
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<td>&lt; 50</td>
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<td>100</td>
</tr>
<tr>
<td>C</td>
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<td>35</td>
<td>35</td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>D</td>
<td>1.25</td>
<td>50</td>
<td>20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E</td>
<td>1.25</td>
<td>70</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Figure 7-1: Misima Mining Project: Company IRR Risk and Tax Policy.

IRR Risk

Inctax (%) and APT (70% - Inctax)
company. For a relatively profitable project, the application of APT in conjunction with the company tax should not have any major impact on a company's IRR.

### 7.4.2 Porgera Mining Project: Tax Policy and Risk Analysis

Porgera in the highlands of Papua New Guinea has received attention since the discovery of gold in the area. Once the mine begins production, its development should benefit Enga Province. Drillings have confirmed a very high grade zone containing approximately 40 grams of gold per tonne mined. A more modest zone average around 5.0 grams of gold per tonne and 16 grams of silver per tonne mined. The total ore reserve is estimated at 138 million metric tonnes making it a fairly large mining project. In its construction phase particularly, but also in the production stage, the project will have a substantial impact on the social and economic life of the people of the Enga Province in addition to the revenue contribution to the central government of Papua New Guinea and the ensuing impact on the economy. The Porgera mining project is a joint venture between Placer (PNG) Ltd and Mount Isa Mines (Australia) Ltd. The government of Papua New Guinea is likely to have a share in the venture which at the present may be in the vicinity of 30 per cent. Provided the negotiations go well, the project may come into production in 1991.

Based on the drilling results of two distinguishable mineralised zones, the present analysis is based on a number of assumptions. As it is common for mining companies to start production in higher quality zones and then move to lower quality zones, it is assumed that the high grade zone will be mined in the first 5 years of production, and once this zone is exhausted, the other zone will be mined for another 20 years. Given the loan obligations the mining company has to repay, it seems logical that it will begin production where returns to costs are at its highest. Given the high quality of the ore, the sales of silver and gold will more than compensate for the costs of extraction and milling.

The Porgera project is likely to be one of the most profitable mines yet exploited in Papua New Guinea. The following analyses portray the range of probabilities on IRR and NPV under different tax policy alternatives. The assumptions and data are listed in the statistical appendices | Appendices D and E |. Following the Misima case-study, the following analyses are brief, attempting only to capture the interesting details of the analyses.

**Total Company Cash Flow IRR**

Cases A and E again depict (Table 7.5) the probabilities of the IRR from a no APT case to a maximum tax policy option. Case A would be the most preferred by the

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9Placer (PNG) Limited assumes a 25 year project life. The model analysis is based on a 20 year projection, thus, in this case the first 20 years of the project life is analysed.
### Table 7-5: Porgera Mining Project: Company IRR and Tax Policy

<table>
<thead>
<tr>
<th>Case</th>
<th>Royalty (%)</th>
<th>Inctax (%)</th>
<th>APT (%)</th>
<th>Policy Range (%)</th>
<th>Probability (%)</th>
<th>Mean</th>
<th>Std</th>
<th>CV</th>
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<td>-</td>
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<td>84</td>
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<tr>
<td>D</td>
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<td>20</td>
<td>-</td>
<td>61</td>
<td>39</td>
<td>-</td>
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<td>70</td>
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### Table 7-6: Porgera Mining Project: Company Equity IRR and Tax Policy

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<thead>
<tr>
<th>Case</th>
<th>Royalty (%)</th>
<th>Inctax (%)</th>
<th>APT (%)</th>
<th>Policy Range (%)</th>
<th>Probability (%)</th>
<th>Mean</th>
<th>Std</th>
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<td>10 - 15</td>
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</tr>
<tr>
<td>D</td>
<td>1.25</td>
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<td>20</td>
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<td>90</td>
<td>10</td>
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<tr>
<td>E</td>
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<td>70</td>
<td>0</td>
<td>76</td>
<td>24</td>
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company because the expectation of achieving an IRR of between 10% to 15% is 55 per cent; for the range 15% or above it is 45 per cent. The government on the other hand would prefer Case E where the maximum tax rate would bring in higher revenues. Case A results in a higher mean IRR compared to Case E but associated with lower risk.

Thus, for both the government and the company the best tax policy alternative would be Case C where the tax rate is half the maximum tax rate allowed. This provides the optimal tax alternative when both parties are considered (Table 7-5). For the company, this is the optimal policy with the least risk (CV).

**Company Equity Cash Flow IRR**

The analysis on the company equity IRR is similar to those on the total cash flow. Case A suggests that a reliance on APT alone gives the lowest IRR with the lowest risk. With the gradual lowering of the APT rate and increasing tax rate, the mean IRR decreases as shown in Cases B to E. In terms of risk, or variation around the mean, the company would prefer to be at Case C which gives the least risky tax option (Table 7-6).

**Company Equity Present Value**

The tax policy option depicted in Table 7-7 regarding company present value supports the analysis of the Misima project. It is also evident that increasing the tax rate lowers the expected present value range as seen in Cases A to E. Again, Case C stands out as the optimal tax policy alternative facing the company given the conflicting objectives of the government.

Employing the maximum tax rate (Case E) suggests that the probability of the company earning less than K50m is 100 per cent. Applying a maximum tax rate as in Case E gives a negative mean expected company equity present value. This seems to suggest that the company is paying too high a tax, and not making enough profits to earn a positive present value. This further explains the reason for not employing this kind of tax policy in the mineral sector in Papua New Guinea.

Increasing the tax rate and lowering the APT rate as in Cases B to E does not necessarily lead to less risk. As Case E suggests, relying totally on a tax rate of 70% results in the highest risk, and therefore the least preferred tax policy for the company. In this scenario, the probability of the company earning K50m or less is 100 per cent.

A combination of APT and tax rates as shown in Cases C and D seem to be the alternatives, and ultimately it would be Case C which give the optimal tax policy option facing the company in relation to the government's revenue-maximising objective.

**Government Net Present Value**

The net present value situation for the government in the Porgera project is similar to that in the Misima case-study. As expected, increasing the tax rate has resulted in an increase in the mean present value (Table 7-8). The reverse would be true for the company for which a tax increase is likely to take away a higher portion of its income.
Table 7-7: Porgera Mining Project: Company Equity Present Value and Tax Policy

| Case | Royalty (%) | Inc. Tax (%) | APT (%) | Present Value Range (Km) | Policy | Mean | Std | CV  
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<td>&lt; 50</td>
<td>50 - 100</td>
<td>100 - 150</td>
<td>150 - 200</td>
<td>&gt; 200</td>
</tr>
</tbody>
</table>
| A    | 1.25        | 0           | 70      | -   | -        | 7         | 26       | 67     | 221.9  
| B    | 1.25        | 20          | 50      | -   | 16       | 37        | 37       | 10     | 147.0  
| C    | 1.25        | 35          | 35      | 15  | 46       | 36        | 3        | -      | 90.8   
| D    | 1.25        | 50          | 20      | 71  | 28       | 1         | -        | -      | -40.3  
| E    | 1.25        | 70          | 0       | 100 | -        | -         | -        | -      | -      

Table 7-8: Porgera Mining Project: Government Net Present Value and Tax Policy

| Case | Royalty (%) | Inc. Tax (%) | APT (%) | Net Present Value Range (Km) | Probability (%) | Mean | Std | CV  
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<td>300 - 400</td>
<td>400 - 500</td>
<td>500 - 600</td>
<td>&gt; 600</td>
</tr>
</tbody>
</table>
| A    | 1.25        | 0           | 70      | -   | -        | 5         | 27       | 68     | 631.6  
| B    | 1.25        | 20          | 50      | -   | 2        | 16        | 56       | 26     | 562.4  
| C    | 1.25        | 35          | 35      | -   | 3        | 23        | 60       | 14     | 537.4  
| D    | 1.25        | 50          | 20      | -   | 3        | 25        | 59       | 13     | 535.6  
| E    | 1.25        | 70          | 0       | -   | -        | 13        | 56       | 31     | 569.2  

Figure 7-2: Porgera Mining Project: Company IRR and Tax Policy.
Case A with the maximum APT rate applied and no tax results in the highest mean present value to the government. This is also the risky tax policy option in terms of variation around the mean present value. The probability of earning K600m or above is 68 per cent. From the company point of view, this option is not favourable. Case B with a tax rate of 20% and an APT rate of 50% show the same risk as Case A; however, the probability of earning K600m or above has been reduced to 26 per cent, and a 56 per cent probability of earning K500m to K600m.

Cases D and E have less variation around their means than all other Cases. Indeed, Case E is the least risky tax policy option with no APT and a maximum tax of 70%. While this may appeal to the government as the best tax policy option, because of the company’s objective of obtaining a return to justify its investment, the parties would settle at Case C which provides the optimal tax policy option. Under the conditions facing the government and the company, Case C is the optimal policy alternative where the government would happily settle for a mean present value of K537.4m, while at the same time accommodating the company’s objective of maintaining a stable income with an optimal tax policy (Table 7.8).

The APT and a Profitable Project

Figure 7.2 plots the company IRR risk on the vertical axis against the tax and APT rates on the horizontal axis. When the APT rate is at its highest (left of 35 per cent tax or APT), the IRR risk is low, with its lowest point on the 35 per cent tax and APT rates. The lowest risk level is the most efficient tax policy in this case. When the tax rate is increased (along the horizontal axis) and the APT rate is lowered, the risk level increases; reaching its peak when the maximum tax rate of 70 per cent is applied. This analysis shows that the higher APT rate has very little effect on the IRR to the company. Instead, it is the increase in the company tax rate which creates greater risk to the company’s IRR. For the Porgera mining project, therefore, the analysis suggests that the APT rate is not a major factor affecting investment.

7.5 Conclusion

The analysis confirms that the RRT or APT is neutral in relation to company’s IRR and hence to investment decisions by mining firms. It must be understood that the APT as it applies to Papua New Guinea is an integral part of the company tax policy in that the APT rate that applies to additional profits is determined by the maximum tax (70 per cent) less the company tax (i.e. 70% - INCTAX). Given this formulation, the APT rate changes only if the company income tax rate changes.

The real factor which determines the amount of APT to be paid is the capital base, and the threshold which determines this base. The threshold determines the amount over
and above normal profits to be subject to the APT. It seems therefore that the neutrality of the APT is dependent on the tax rate that is imposed on normal taxable income, and any additional profits are then taxed as a proportion of this tax rate. If the threshold rate under- or over-estimates the 'supply price of investment', then the neutrality condition of the APT may be violated. As Palmer (1980, p.258) suggests, the important advantage of the APT system is that it is based on the revealed profitability of the mining project depending on a host of factors such as mineral prices, operating costs, loan payments, etc. This makes it more versatile and self-adjusting than most other tax systems.

Using a somewhat modified APT formulation in the Bougainville project, the analysis shows that the APT alone does not affect cash flows to the company. Any effect it has on company cash flows is part of the income tax rate. The raising of APT rate is not associated with a corresponding increase in risk (coefficient of variation) of company cash flows. Intuitively, the APT should not affect the mean company cash flows since it applies only to the additional profits tax after payment of taxes and interest and loan payments. However, the fact that the company tax and APT are integrated also implies that the overall effect of the combination of these taxes will affect the NPV and IRR of the company if one or the other increase or decrease.

This analysis confirms the neutrality of the APT system as first proposed by Garnaut and Clunies Ross (1975) and applied to the Bougainville project in Papua New Guinea. The APT is a self-adjusting tax mechanism which operates automatically along with company tax if and when super-normal profits are earned. The super-normal profits are determined by the threshold rate used. The threshold rate is fixed in the legislation and the mining company is given the option to choose the rate it prefers as in the Ok Tedi and the General Mining Legislation. The threshold rate reflects the perceived 'supply price of investment' in the mining sector in that country. Because of the APT system being a component of the company tax system, this particular option makes the Papua New Guinea mining and taxation policy particularly attractive to foreign investors.

The results of the case-studies do not support the proposition that the APT is a deterrent to investment in the mining sector. If we hold company cash flows and equity present value as equivalent to investment actually undertaken in the mining sector, we find that resource rent taxes have not provided a disincentive to investment. At least in Papua New Guinea, the historical analysis has shown the neutrality of APT in terms of

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10 The APT formulation for the Bougainville mine used here is a modified version of the original formula since all variables necessary to apply the latter are not available (see equations D.42 - D.48, Appendix D).
company cash flows. What it appears to have done was to bring greater risk to the
government in terms of greater variation around mean government revenue. Indeed,
current mining activities seem to support the optimality of the tax policy alternatives
presented in Case C in both projects. In Papua New Guinea, therefore, the current tax
policy in the mining sector is efficient and worth preserving if mining investments are to
continue to flow into the country.
CHAPTER 8
CONCLUSION

The empirical literature on the effects of export instability on growth and development of the developing countries is inconclusive for cross-sectional studies. The literature on individual country studies portrays the effects arising from varying economic environments and responses. The cross-sectional approach to studying the effects of export instability is limited by assumptions of similar economic and institutional factors affecting exports of developing countries. Evidence from individual country studies, even those with similar economic conditions, appear to contradict this assumption and therefore puts in question the cross-sectional approach.

Individual country studies of the effects of export instability are relatively few. With only the exception of Lim’s (1972) study of West Malaysia, all other studies found some evidences that export instability has negative effects on the growth and welfare of developing countries.

Reviewing the South Pacific island country studies highlights the differing degree to which particular countries can be affected by export instability. These studies, Fairbairn (1984), Altman (1977 and 1978) and Knapman and Schiavo-Campo (1984), all indicate the different ways in which export fluctuation affect different economies. The economic responses to export instability are therefore likely to be different. The degree to which any one country is affected by fluctuating export earnings is very much dependent on how the domestic policy framework deals with the effects of export instability.

The analysis of Papua New Guinea suggests that export instability has a negative effect on welfare and growth; however, there seem to be some offsetting mechanisms at work. Though the offsetting effects could not be determined directly, it can be inferred that domestic commodity stabilisation in the agricultural sector and the flow of Australian aid to the public sector had some stabilising effects. Fluctuating government revenues, however, lead to unstable planning for public programmes in the country.

The establishment of the MRSF recognized the importance of instability transmission through mineral revenues because of high volatility of mineral prices. Mineral revenues through the MRSF flows are, however, still shown to be an important channel of transmission of export instability. The tendency for Papua New Guinea to be
highly dependent on minerals may even mean greater fluctuations in the revenue base in the long run; this therefore calls for a better fiscal regime that will capture the rents available through 'boom' periods, which are then used in 'bust' periods.

The review and comparison of mineral taxation policies in some countries of the ASEAN region highlight that taxes which are not based on mineral rent, for example, those based on volume and value of output do not allow for full cost of producing the mineral. Such forms of tax restrict mining activities. Taxes which do not adjust automatically to changes in mine profitability are unable to capture a significant share of mineral rents. A tax which adjust automatically to the profitability of a mine may increase risk to the taxing authority, but at the same time increase the share of mineral rent.

The APT in conjunction with the company tax system is a fiscal regime which captures this rent. It is shown to be neutral with respect to private investment decisions in the analysis presented in this study. As it is a component of the overall company tax system in the mining sector, we find that the APT has a negligible effect on company cash flows. This is not surprising since the APT is a tax on surplus profits after normal company tax has been imposed. The analysis also shows that the APT only changes when the company tax rate changes as the two are integrated. The APT system, as applied to the mining sector, is not and need not be a deterrent to investment in that sector. It is the company tax which has a greater impact on cash flows than the APT.

Mean, Variability Approach and the APT

The historical analysis of Bougainville, and the Misima and Porgera case-studies indicate that the APT type of resource rent tax as applied in Papua New Guinea does not create a risk to company cash flows. Any risk in cash flows and therefore investment that may arise originates from company income tax which brings about swings in income after-tax. The APT only comes in where super-normal profits are earned. The latter are not adequately captured by the normal company tax. The analysis thus supports the theoretical argument that the APT creates no additional risk to investment in mining in Papua New Guinea.

The analyses further shows that if risks exist in conjunction with the APT, they are borne by the taxing authorities. The risks arise from fluctuations in mineral prices. Obviously, if the host government were to rely on one mineral commodity, the fluctuation would be greater and so would be the risk in revenue earnings. The mineral tax policy currently in operation in Papua New Guinea is much more efficient than plausible alternatives.

The establishment of the MRSF in Papua New Guinea was principally to stabilise the revenue flows to the government. The present analysis confirms the importance of the
MRSF because of fluctuations in mineral prices and hence revenues to the government. The APT adds to the fluctuation around a mean income to the government, but if a part of the super-normal profits was not captured in this way it would solely benefit the investors. Super-normal profits are due principally to swings in mineral prices.

Export Instability and Mineral Taxation Policy

Chapter 6 shows that the MRSF is an important channel of transmitting export instability in Papua New Guinea. Thus, it follows that the mineral tax policy has an impact on export instability in the mining sector, and therefore on government revenues.

Fluctuating export earnings due to swings in mineral prices require a two-tier tax system to capture the benefits to the host government without discouraging investment. The company income tax, royalty and the APT package as applied to the mining sector in Papua New Guinea captures the benefits of mineral exploitation for the government.

Marginal Mining Project and the APT

It is true that the APT increases the expected tax burden borne by mining companies. However, in the case of Papua New Guinea, a more recent study suggests that "the overall burden does not appear unduly high", and it is therefore "difficult to fault APT for increasing that burden" [Tilton, et. al.: 1986: 58]. The present analysis shows that the risk to the company due to the APT is not high.

Amongst its disadvantages the above authors also suggest that the progressivity of the APT "shifts some of the risk associated with mining to the government" [Tilton, et al.: 1986: 58]. This proposition is borne out in this analysis where increasing the APT rate and lowering the company tax rate shifts the risk to the government in terms of more variation around mean revenues. However, contrary to their suggestion that "the APT also tends to discriminate against complex, high risk projects such as Porgera and Ok Tedi" (1986, p.58), the analysis presented in Chapter 7 shows that the marginal projects such as Misima bear much of the risk. Under conditions of risk and uncertainty, Ball and Bowers (1984, p.15) suggests that "the RRT would have its greatest impact upon marginal projects. While they were referring specifically to the Australian resource rent tax system, it is still consistent with the literature where the marginal projects are discriminated against by the application of the company tax and APT rates compared to the relatively more profitable projects. It is obvious that the more profitable projects would fare well despite the use of company tax, royalty and APT; whereas the marginal projects would be better off with lesser rates of each, or the abolition of APT. In the case of the Misima project, it has been argued that the use of APT may make the mine unprofitable.

Nonetheless, the study by Tilton, Millet and Ward (1986) supports the main conclusion of this analysis, suggesting that the APT as a form of resource rent tax
presently used in Papua New Guinea is neutral in that it does not deter foreign investment in the mining sector. In their view, inhibition of investment in mining is principally due to the administrative structure of the agencies dealing with the processing and assessment of applications from prospective mining firms wishing to explore and develop mines in the country.

The APT and Neutrality

The question of neutrality of a rent tax such as the APT is further confirmed in Chapter 7. Using the mean, variability approach the APT as it applies to Papua New Guinea does not necessarily lead to greater risk to mining investors. Since the APT is meant only to apply to super-normal profits, this is not at all surprising. It appears, therefore, that the proposition put forward by Garnaut and Clunies Ross (1975 and 1979) on the neutrality of the APT is supported by the present analysis.

The APT and MRSF

The debate that a resource rent tax such as the APT is a penalty on investment decisions is not supported by the present analysis. Since the APT is a component of a two-tier tax system, its most direct impact is on super-normal profits. Normal profits are subject to company tax. The APT is used in conjunction with the company tax to capture mineral rents in the mining sector in Papua New Guinea. The package has worked fairly successfully in recent years. The use of the MRSF to stabilise government revenue from mining was based on the fluctuating nature of mineral prices. Stability in public expenditure programmes is important for a developing country such as Papua New Guinea. When new mines come into production, the MRSF will have to provide the major burden of stabilisation in the Papua New Guinea economy.
Appendix A

EXPORT INSTABILITY INDICES: DERIVATION AND DESCRIPTION

A.1 Coppock Index (CI)

\[ V \log = \sum_{t=1}^{N} \frac{\log X_{t+1} - m}{N} \]

\[ I-I = \text{antilog} \left( \sqrt{V \log} \right) \]

where \( X_t \) is the value of a country's exports in year \( t \); \( N \) is the number of years minus 1; \( m \) the arithmetic mean of the differences between the logs of \( X_{t+1} \) and \( X_{t-2} \); etc; and \( V \log \), the logarithmic variance of the series [Coppock, 1962: 24].

Unless otherwise stated I-I will denote instability index.

A.2 Standard Error (SE)

\[ \frac{(u_t)^2}{N^{1/2}} \]

where \( u_t = Z_t - (b_0 + b_1 t) \) is the unexplained variance; \( Z_t \) is exports in year \( t \); \( N \) is the number of years; and \( \bar{Z} \) is the mean of exports over that period [Stein, 1977: 280].

A.3 Average Annual Percentage Change (APC)

\[ \frac{w_t}{N} \]

where \( w_t = \frac{u_t - 1 - u_t}{\max Z_t Z_{t+1}} \) and other variables are as defined above.

A.4 Moving Average Corrected for Trend (MAC)

\[ \frac{100}{\bar{X}} \sum_{t=2}^{N} \frac{X_t - X_{t-1} - b}{N-1} \]

where \( X_t \) is the value of exports; \( \bar{X} \) is the average of exports; \( b \) is the slope of linear trend \( X = a + b t \) fitted by OLS method [Stein, 1977: 281; Glezakos, 1973: 672].
A.5 Moving Average (MA)

\[ \sqrt{n} \sum_{i=1}^{n} \frac{X_i - \overline{X}_i}{\overline{X}_i} \times 100 \]

where \( X_i \) is merchandise exports in year \( i \); and \( \overline{X} \) is the \( n \)-year moving average of merchandise exports centred on year \( i \); \( n \) is the number of years; and \( i = 1 \) the base period [Lim, 1980: 261].

A.6 Standard Deviation Corrected (SDC) for Trend

\( (i) \quad E_t = aE_{t-1} + u_t \)

where \( u_t = u + b \text{time} \); and \( E_t \) is export earnings.

\( (ii) \quad E_t = a_0 + a_1 \text{time} + a_2 E_{t-1} + e_t \)

where \( a_0 \) approximates \( u \); \( a_1 \) approximates \( b \); \( a_2 \) approximates \( E_t \); and \( e_t \) approximates \( u_t \). The standard error of the regression equation (i.e. \( e_t \)) will serve as proxy for \( \rho \), and when multiplied by \((100/E)\) will give the instability index.

\( (iii) \quad E_t = a_t + a_2' E_{t-1} + w_t \)

where \( w_t = \epsilon_t - \epsilon_{t-1} \) is the simplest first-differencing the regression equation which is necessary when there is serial correlation in the error terms [see Kenen and Voivodas, 1972: 793-794].

A.7 UNCTAD Index (UI)

\[ \sum_{t=1}^{N} \frac{y_t - \overline{y}_t}{\overline{y}_t} \times N \times 100 \]

where \( y_t, \overline{y}_t \), and \( N \) are the actual magnitudes of the variables, its exponential trend level and the number of observations, respectively [see UNCTAD, 1984: 7].

A.8 Standard Deviation-Maximum Likelihood (SDML)

\( (i) \quad \frac{S}{\overline{X}} \)

where \( \overline{X} \) is the mean value of export earning series; and \( S \) is derived from the following:
(ii) \[ S^2 = \frac{1}{n} \sum_{t=1}^{n} (X_t - X_t^2) \]

where \( X_t \) is the trend (or expected value) of series \( X_t \).

To find a general instability index that would best fit the data, the maximum likelihood is required; thus:

(iii) \( (x_t - 1) \frac{1}{N} = a + b_t + u_t \)

when \( \lambda = 1 \), the above becomes linear, and when \( \lambda > 0 \) it approaches a logarithmic form. Using the maximum likelihood procedure this becomes:

(iv) \[ X_t^* = \begin{cases} \lambda(a + b_t - 1) & \text{if } \lambda = 0 \\ \exp(\bar{a} + \bar{b}_t) & \text{if } \lambda = 0 \end{cases} \]

The estimates of the parameters \( \bar{a}, \bar{b} \), and \( \lambda \) were obtained using (iii) above, and the likelihood ratio test was performed to test if \( \lambda \) differed from the traditional value of 0 and 1. When one of the two tests could not be rejected, the corresponding value was adopted to calculate the trend [see Moran, 1983: 198-199].

A.9 Normalised Standard Error (NSE)

\[ \sum_{t=1}^{n} \epsilon_t^2 = n \frac{1}{T X} \]

where \( \epsilon_t^2 \) is the squared residual in period \( t \); \( n \) is the number of years used to construct the trend; and \( T X \) is the average total value of exports over the period as a whole [see Soutar, 1977: 284].

A.10 Standard Deviation (SD)

\[ \log X_t = a + rt + \epsilon_t \]

where \( \log X_t \) is the natural log of the dollar value of merchandise exports; \( a \) is the constant term; \( r \) is the growth rate of export over the period considered; and \( \epsilon_t \) is the error term in time period \( t \). The difference between the actual and expected values (in logs) of a country’s exports is represented by \( \epsilon_t \), and the estimated deviation of \( \epsilon_t \) is used as the index of instability [see Naya, 1973: 631].
A.11 Transitory Income (TI)

The transitory income instability indices are derived as follows:

\[ I_E = \sum_{t=1}^{T} \frac{(E_t - E_t^*)^2}{(E_t)^2} \]

\[ I_D = \sum_{t=1}^{T} \frac{(D_t - D_t^*)^2}{(D_t^*)^2} \]

where \( I_E \) is the transitory income index of export instability; \( I_D \), the transitory income index of domestic instability; \( D_t \), the actual domestic income; \( D_t^* \), permanent domestic income; \( E_t \), actual export income; \( E_t^* \), permanent export income; and \( T \), period of observation.

The values for \( D_t^* \) and \( E_t^* \) were estimated from the consumption model equation as follows:

\[ C_t^* = K_D D_t + K_E E_t^* \]

where \( C_t^* \) represents permanent consumption; \( K_D \), the propensity to consume out of permanent income; \( K_E \), the propensity to consume out of export income; and \( D_t^* \), \( E_t^* \) as denoted above [see Knudsen and Parnes, 1977: 119-120].

A.12 Variance - Covariance (V-C)

\[ V_t = x_m V_m + x_s V_s + x_m x_s \text{cov}(m,s) \]

where \( V_t \) is the weighted average of the variance and covariance of earning from two sources: major source (m) and all other source (s); \( x_m \) and \( x_s \) are the respective shares.

The contribution of the major source of export instability in total earnings can be written as follows:

\[ C_m = x_m^2 V_m + x_m x_s \text{cov}(m,s) \]

The 'proportionate contribution statistic' for the major source is given by:

\[ P_m = \frac{C_m}{V_t} \]

The possibility that the major source major contribute disproportionately to total instability may be checked by examining the ratio of the 'proportionate contribution statistic' to the export share of the major source. This ratio is expressed as:

\[ R_m = \frac{P_m}{x_m} \]
Appendix B

GINI - HIRSCHMAN CONCENTRATION INDICES

\[ C_{zt} = \left( \sum_{j=1}^{n} \frac{X_{zt}}{X_t} \right)^{2/1} \times 100 \]

where \( X_{zt} \) is the value of exports of commodity \( j \) in year \( t \); and \( X_t \) is the export earnings in that year.

In the case where \( X_{jt} \) represents the value of exports to market \( j \) in year \( t \), then \( C_{zt} \) measures the degree of geographical concentration (see Love, 1979: 61-62; Yotopoulos and Nugent, 1976: 339).
Appendix C

DIFFERENCES IN THE BOUGAINVILLE, OK TEDI AND GENERAL MINING LEGISLATION APT FORMULATIONS

C.1 The Basis for APT Calculations in the 1974 Bougainville Agreement.

The tax formula for determining the tax base payable on the taxable income in the case of the Bougainville project is the following:

\[ N = \frac{M \times C}{K \times F / B} \]

where

- \( N \) = the 'initial investment' up to the tax year, and this amount is equal to \( M \) in the preceding tax year (or adjustment year);
- \( K \) = the capital factor (opening capital stock) at the end of the calendar year preceding the adjustment year;
- \( C \) = the capital factor (closing capital stock) at the end of the adjustment year (i.e. \( C_{t-1} \)), and this equals \((K + E - R)\).
- \( E \) = capital expenditure in the mining of ores;
- \( R \) has two components, it is the sum of: (a) the total amount of depreciation on capital equipment in excess of 5 per cent per annum; and (b) the original cost of other capital equipment (not already included above) replaced, disposed of, lost or destroyed in the adjustment year;
- \( B \) = the average of the daily buying rate of the kina against the US dollar during the adjustment year; and
- \( F \) = the average buying rate of the kina against the US dollar during the tax year.

C.2 The Ok Tedi APT Formulations.

\[ A = \frac{F}{E} \times B (100 + R) + C \]

where

- \( A \) = accumulated value of the net cash receipts at the end of the tax year for which the calculation is being made;
- \( B \) = accumulated value of the net cash receipts at the end of the tax year immediately preceding the tax year for which the calculation is being made;
C = the net cash receipts in the tax year for which the calculation is being made;

E = average annual buying rates of the Kina against the US dollar during the tax year for which the calculation is being made (expressed in terms of Kina per US dollar);

F = average annual buying rates of the Kina against the US dollar during the tax year (expressed in Kina per US dollar); and

R = the accumulation rate which the company shall choose at the commencement of commercial production of the mine either: (a) twenty percent (20%) or (b) annual percentage rate of interest on domestic borrowings rated AAA in the US plus 12 percent (Daniel (1985); Emerson (1984) and Pintz, 1984: 65).

Clause 23 of the Ok Tedi Agreement gives detailed definitions of the above items; for our purpose a number of definitions need a brief explanation. Net cash receipts (NCR) used in this context represent the result (which may be negative) of (a) the sum of all sales of ores and concentrates by company and other receipts, and (b) the sum of all expenditures and other payments allowable for deduction for income tax purposes (Papua New Guinea, 1976: 38). The net assessable receipts (NAR) is the "excess of assessable receipts over deductible payments" (Garnaut and Clunies Ross, 1977: 82).

The tax provisions provide for additional profits tax to be paid if the net cash receipts in any tax year is positive. The formula for calculating APT is as follows:

\[ APT = A \times (70\% - T) \]

where

APT = amount of additional profits tax in Kina;

A = accumulated value of NCRs in Kina for the tax year in respect of which the calculation is being made;

T = the normal percentage rate of company income tax in Papua New Guinea for the tax year in respect of which the calculation is being made (Papua New Guinea, 1976: 44).

C.3 APT Formulation Under the General Mining Legislation.

The accumulated value of net cash receipts in relation to mining operations carried out by the taxpayer on a special mining lease under the General Mining Regime is the following:

\[ N = F/E \times A \times (100\% - R) + B \]

where

N = the accumulated value of the net cash receipts at the end of the tax year for which the assessment is being made;

A = the accumulated value of net cash receipts at the end of the preceding year of income;
B = the net cash receipts of the year of income in respect of which the assessment is to be made;

\[ R = \text{the accumulation rate}; \]

\[ E = \text{the mean of the average of the daily published buying and selling rates of Kina against the US dollar during the year of income immediately preceding the year for which the calculation is being made (expressed as Kina per US dollar)}; \]

\[ F = \text{the mean of the average of the daily published buying and selling rates of the Kina against the US dollar during the year of income for which the calculation is being made (expressed as Kina per US dollar)}. \]

From the above and based on the same principle as the Ok Tedi APT calculation, the APT under the General Regime is then calculated as:

\[ \text{APT} = N \times (70\% - n) \]

where \( N \) accumulated net receipts from which APT is calculated; and \( n \) is the normal company tax rate. Note that the accumulation only takes place only when negative receipts are earned. For positive cash receipts, the APT is paid for that year.
Appendix D

MODEL EQUATIONS AND DEFINITIONS

Mineral Price Equations

Three mineral types will be subject to analysis in the context of the mineral sector in Papua New Guinea. These are copper, gold and silver.

\[
\frac{PC_t}{USDEF} = a + bt + \epsilon_t
\]  \hspace{1cm} (D.1)

\[
\frac{PG_t}{USDEF} = a + bt + \epsilon_t
\]  \hspace{1cm} (D.2)

\[
\frac{PS_t}{USDEF} = a + bt + \epsilon_t
\]  \hspace{1cm} (D.3)

where \(\ln PC\), \(\ln PG\) and \(\ln PS\) are respectively natural logarithm of prices of copper (US$/tonne), gold (US$/oz) and silver (US$/oz). These prices are deflated by the US GDP deflator (USDEF) to convert them to constant values. While the Bougainville mineral prices are in kina, the other mines (Misima and Porgera) the model converts the price of gold, silver and copper into kina by multiplying by the exchange rates (Kina/US$).

In the static (Bougainville) analysis, the price equations are based on the concentrate prices in kina. These are depicted as below:

\[
\ln CPC_t = a + bt + \epsilon_t
\]  \hspace{1cm} (D.4)

\[
\ln CP_G_t = a - bt + \epsilon_t
\]  \hspace{1cm} (D.5)

\[
\ln CPS_t = a - bt + \epsilon_t
\]  \hspace{1cm} (D.6)

In equations (D.1) to (D.6), regressing price on time \((t)\) give the respective growth rates of mineral prices where \(b\) is the rate of growth of price, \(a\) is the intercept and \(\epsilon_t\) is the error term.

Detrending
To separate out the natural growth rates of prices from the time trend, it became necessary to detrend as below.

\[
\ln (\text{PC}_t - \text{PC}'_t) = AC - BC \ln (\text{PC}_{t-1} - \text{PC}'_{t-1}) + (\epsilon_t - \rho \epsilon_{t-1}) \tag{D.7}
\]

\[
\ln (\text{PG}_t - \text{PG}'_t) = AG - BG \ln (\text{PG}_{t-1} - \text{PG}'_{t-1}) + (\epsilon_t - \rho \epsilon_{t-1}) \tag{D.8}
\]

\[
\ln (\text{PS}_t - \text{PS}'_t) = AS - BS \ln (\text{PS}_{t-1} - \text{PS}'_{t-1}) + (\epsilon_t - \rho \epsilon_{t-1}) \tag{D.9}
\]

where \( \ln \text{PC}'_t \), \( \ln \text{PG}'_t \) and \( \ln \text{PS}'_t \) are the fitted values of the time trend. The actual values less the fitted values give the detrended values and \( \epsilon_{t-1} \) and \( \rho \) are the error terms. These equations have been derived using autoregressive methods. The parameters obtained from equations (D.7) to (D.9) are then used in the generation of prices and sales in the stochastic analysis.

\[
\text{LPCT} = \ln \text{PC}_0 - GPC x t \tag{D.10}
\]

\[
\text{LPGT} = \ln \text{PG}_0 - GPG x t \tag{D.11}
\]

\[
\text{LPST} = \ln \text{PS}_0 - GPS x t \tag{D.12}
\]

where \( \text{LPCT} \), \( \text{LPGT} \) and \( \text{LPST} \) use growth rates generated from (D.1) to (D.3) depicted as \( GPC \) (copper), \( GPG \) (gold) and \( GPS \) (silver), while \( t \) is time (years).

\[
\text{LPC} = \text{LPCT} + \text{EC} \tag{D.13}
\]

\[
\text{LPG} = \text{LPGT} + \text{EG} \tag{D.14}
\]

\[
\text{LPS} = \text{LPST} + \text{ES} \tag{D.15}
\]

where \( \text{LPCT} \), \( \text{LPGT} \) and \( \text{LPST} \) are derived from the previous equations while \( \text{EC} \), \( \text{EG} \) and \( \text{ES} \) are the error terms (i.e. the standard error of the estimates of equations (D.7) to (D.9)). For the subsequent years (i.e. year two and onwards), the equations become

\[
\text{LPC} = \text{LPCT} + AC + BC [\text{LPCT}(t-1) - \text{LPCT}(t-1)] + \text{EC} \tag{D.16}
\]

\[
\text{LPG} = \text{LPGT} + AG + BG [\text{LPG}(t-1) - \text{LPG}(t-1)] + \text{EG} \tag{D.17}
\]

\[
\text{LPS} = \text{LPST} + AS + BS [\text{LPST}(t-1) - \text{LPST}(t-1)] + \text{ES} \tag{D.18}
\]

where \( \text{LPCT}(t-1) \), \( \text{LPGT}(t-1) \), \( \text{LPG}(t-1) \), \( \text{LPST}(t-1) \) and \( \text{LPST}(t-1) \) are as defined above but lagged one year; while \( AC \), \( AG \) and \( AS \) are constants and \( BC \), \( BG \) and \( BS \) are the parameter estimates of equations (D.7) to (D.9). \( \text{EC} \), \( \text{EG} \) and \( \text{ES} \) are the error terms.
Covariance of Gold, Silver and Copper Prices

The covariance matrix used in the model is derived from equations (D.7 to D.9). These are actually the regression of residuals from these equations as below:

\[ \text{RPG} = \alpha + \beta \text{RPC} + [\epsilon_t + \rho_t] \]  
\[ \text{RPS} = \alpha + \beta \text{RPG} + [\epsilon_t + \rho_t] \]  
\[ \text{RPG} = \alpha + \beta \text{RPS} + [\epsilon_t + \rho_t] \]  

where RPG is the residual of the price of gold, RPC is the residual of the price of copper and RPS is the residual of the price of silver, while \( \epsilon_t \) and \( \rho_t \) are the autoregressive error terms.

Sales

\[ \text{SALES} = \text{QC} \times \exp(\text{LPC}) + \text{QG} \times \exp(\text{LPG}) \]  
\[ \text{SALES} = \text{QG} \times \exp(\text{LPG}) + \text{QS} \times \exp(\text{LPS}) \]  

Sales in Kina

\[ \text{KSALES} = \text{SALES} \times \text{EXRATE} \]  

Inflated Sales

\[ \text{SALES} = \text{SALES} \times \exp(\text{RATE}_1 \times T) \]  

Operating Cost

\[ \text{OPCST} = (\text{OCC} \times \text{QC}) + (\text{OGG} \times \text{QG}) \]  
\[ \text{OPCST} = (\text{OCC} \times \text{QG}) + (\text{OSS} \times \text{QS}) \]  

Inflated Operating Costs

\[ \text{IOPCST} = \text{OPCST} \times \exp(\text{RATE}_2 \times T) \]  

Depreciation

\[ \text{DEP} = \text{CAPTAL} \times \text{DEPRT} \]  

Carry Forward Depreciation

\[ \text{CFDEP} = \text{CAPTAL} \times (\text{(1 - DEPRT)} / (1 / \text{DEPRT})) \]  

Loans and Payments by Company

\[ \text{CLK} = \text{CL} \times (1 - \text{GK}) \times \text{CAPTAL} \]  
\[ \text{CLP} = \text{P} \times \text{R} \left(1 + \text{R}\right)^n / \left(1 + \text{R}\right)^{n-1} \]
Loans and Payments by Government

\[ GLK = GL \times GK \times \text{CAPTAL} \]  \hspace{1cm} (D.33)

\[ GLP = P \times R \frac{(1 - R)^n}{(1 + R)^{n-1}} \]  \hspace{1cm} (D.34)

Interest Payments on Loans by Government

\[ GLI = GLK \times GLR \]  \hspace{1cm} (D.35)

\[ GPR = GLK - (GLP - GLR) \]  \hspace{1cm} (D.36)

\[ GLI = GLK \times GLR \]  \hspace{1cm} (D.37)

Interest Payments on Loans by Company

\[ CLI = CLK \times CLR \]  \hspace{1cm} (D.38)

\[ CPR = CLK - CLP + CLI \]  \hspace{1cm} (D.39)

\[ TLI = CLI + GLI \]  \hspace{1cm} (D.40)

Taxable Income and Income Tax

\[ TINC = \text{SALES} \times (1 - \text{ROYLTY}) - \text{OPCST} - \text{DEP} - CLI - CLP \]  \hspace{1cm} (D.41)

\[ \text{TAX} = TINC \times \text{INCTAX} \]  \hspace{1cm} (D.42)

Excess Profits and APT in the Bougainville Agreement (1974)

\[ CFAPT = TINC - \text{TAX} - DDEP \]  \hspace{1cm} (D.43)

If \( CFAPT > 0.0 \), then

\[ \text{CAPADJ} = \text{CAPTAL} \times (1.0 - GK) \times \text{EXRATE}_t / \text{EXRATE}_{t-1} \]  \hspace{1cm} (D.44)

\[ ACB = \frac{\text{CAPADJ} \times \text{APTPRF}}{(1 - \text{INCTAX}) \times (\text{MAXTAX} - \text{INCTAX})} \]  \hspace{1cm} (D.45)

\[ \text{APTCAL} = \text{CAPADJ} + ACB \]  \hspace{1cm} (D.46)

\[ \text{NCB} = ACB - \text{APTCAL} \]  \hspace{1cm} (D.47)

If \( \text{NCB} > ACB \), then

\[ \text{APT} = \text{NCB} \times (\text{MAXTAX} - \text{INCTAX}) \]  \hspace{1cm} (D.48)

If \( \text{NCB} < ACB \), then

\[ \text{APT} = 0.0 \]
Excess Profits and APT Under the General Mining Legislation

\[ CF_{APT} = TINC \cdot TAX + DD\] 

If \( CF_{APT} < 0.0 \), then

\[ AC_{FAPT} = AC_{FAPT} + CF_{APT} \] (D.49)

\[ APT_{ADJ} = AC_{FAPT} \times (1.0 + APT\text{PRF}) \] (D.50)

\[ AP_{ADJ} = APT_{ADJ} \times EXR_{t}/EXR_{t-1} \] (D.51)

\[ AC_{FAPT} = \text{ABS}(AC_{FAPT}) + \text{ABS}(AP_{ADJ}) \] (D.52)

\[ APT = 0.0 \]

If \( CF_{APT} > 0.0 \), then

\[ APT = CF_{APT} \times (M\text{AXTAX} - IN\text{CTAX}) \] (D.53)

Company Cash Flow

\[ CCF = (1 - GK) \times (CF_{APT} - APT) - CLP - CL\text{INT} \] (D.54)

Company Investment

\[ CIN\text{V} = CAP\text{ITAL} \times (1 - GK) \] (D.55)

Company Equity Cash Flow

\[ CE_{Q} = CCF - CLP - CL\text{INT} \] (D.56)

Company Equity Capital

\[ CE_{K} = (1.0 - CL) \times (1.0 - GK) \times CAP\text{ITAL} \] (D.57)

Government Cash Flow and Investment

\[ GI = CAP\text{ITAL} \times GK \] (D.58)

\[ GCF = SALES \times ROY\text{LTY} - TAX - GK \times (CF_{APT} - APT) - GLP \] (D.59)

Project Cash Flow

\[ PCF = SALES - OPC\text{ST} \] (D.60)

Project IRR

\[ IRR_{current} = \frac{PCF_i}{(1.0 + CDRT)^n \times 100} \] (D.61)
Investment Methods Applied for Mining Projects

Company Total Cash Flow IRR

\[
IRR_{CCF} = \frac{PCF_t}{((1.0 + CDRT)^n / (1.0 + INFL)) - 1.0} \times 100
\]  \quad (D.62)

Company Equity IRR

\[
IRR_{CEF} = \frac{CEQ_t}{((1 + CDRT)/100)^n}
\]  \quad (D.63)

Company Net Present Value

\[
CENPV = \sum_{t=1}^{n} \frac{CEQ_t}{(1 + CDRT)^n}
\]  \quad (D.64)

Government NPV

\[
GNPV = \sum_{t=1}^{n} \frac{GCF_t}{(1 + GDRT)^n}
\]  \quad (D.65)

Project Net Present Value

\[
NPV = \sum_{t=1}^{n} \frac{PCF_t}{(1 + CDRT)^n} - CAPTAL
\]  \quad (D.66)
Table D-1: Model Variables and Definitions.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
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<td>Sales converted to kina ($US x kina rate)</td>
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<td>Copper ('000 tonne)</td>
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<tr>
<td>QG</td>
<td>Gold ('000 ounces)</td>
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<tr>
<td>QS</td>
<td>Silver ('000 ounces)</td>
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<td>Inflation rate (5%)</td>
</tr>
<tr>
<td>RATE2</td>
<td>Inflation rate (5%)</td>
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<td>T</td>
<td>Time (years)</td>
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<tr>
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<td>Inflated OPCST</td>
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<td>Carry Forward Depreciation</td>
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<td>R</td>
<td>Rate of Interest</td>
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<td>GLP</td>
<td>Government Loan Payments</td>
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<td>GP</td>
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Table D-2: Model Parameters and Definitions for Bougainville, Misima and Porgera Mining Projects.

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</table>

Note:
(i) BCL (Bougainville Copper Ltd or Bougainville mine).
(ii) The analysis for Porgera only deals with the first 20 years of the project even though it is assumed that it will have a 25-year project life.
Appendix E
STATISTICAL AND DATA APPENDICES
<table>
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<tbody>
<tr>
<td>Copper (Cu) (10 x 3 ozs)</td>
<td>124.0</td>
<td>182.7</td>
<td>184.1</td>
<td>172.5</td>
<td>176.5</td>
<td>182.3</td>
<td>198.6</td>
<td>170.8</td>
<td>146.8</td>
<td>165.4</td>
<td>170.0</td>
<td>183.2</td>
<td>164.4</td>
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<tr>
<td>Cu Value (Km)</td>
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<td>224.8</td>
<td>227.5</td>
<td>151.4</td>
<td>192.6</td>
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<td>1160.0</td>
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<td>660.6</td>
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<td>650.5</td>
<td>718.5</td>
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Notes:
(i) All quantities are concentrate output.
(ii) Gold and silver were in grams but converted to ounces.
(iii) 1 oz = 31.1 gms.

Source:
Table E-2: Calculating Unit Operating Costs for the Bougainville Mine

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<tr>
<td>Copper (10 x 3 tonnes)</td>
<td>124.0</td>
<td>182.7</td>
<td>184.7</td>
<td>172.5</td>
<td>176.5</td>
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</tr>
<tr>
<td>Copper (K/t)</td>
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<td>372.0</td>
<td>362.0</td>
<td>429.0</td>
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<td>459.0</td>
<td>403.0</td>
<td>508.0</td>
<td>580.0</td>
<td>644.0</td>
<td>562.0</td>
<td>607.0</td>
<td>724.0</td>
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<tr>
<td>Gold (K/oz)</td>
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<td>34.0</td>
<td>53.0</td>
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<td>161.0</td>
<td>156.0</td>
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<tr>
<td>Silver (K/oz)</td>
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<td>0.5</td>
<td>0.6</td>
<td>1.0</td>
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Source:

Same as Table E-1.
Table E-3: Misima Mining Project: Ore and Concentrate.

<table>
<thead>
<tr>
<th>Year</th>
<th>Ore Milled ('000 tonnes)</th>
<th>Grade (gm/tonne)</th>
<th>Ore Milled ('000 gms)</th>
<th>Concentrate ('000 ounces)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Au (A)</td>
<td>Ag (B)</td>
<td>Au (D)</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
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</tr>
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<td>15.0</td>
<td>5500</td>
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<td>2600</td>
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<td>15.5</td>
<td>6240</td>
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<td>2.2</td>
<td>14.6</td>
<td>6600</td>
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<tr>
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<td>3200</td>
<td>2.4</td>
<td>15.2</td>
<td>7600</td>
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<td>15.5</td>
<td>7500</td>
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<td>6160</td>
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<td>5520</td>
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</table>

Notes:
(i) The tonnage used are calculated from the project's total ore reserve and may exactly represent total tonnage.
(ii) 1 oz = 31.1 gms.
(iii) Au (92% concentrate recovery), Ag (75% concentrate recovery).
(iv) (D) = (A) x (B); (E) = (A) x (C); (F) = (D)/31.1 x .92; and (G) = (E)/31.1 x .75.

Source:
Data on total reserve from:
Placer (PNG) Limited.
Table E-4: Calculation of Unit Operating Costs for Misima and Pogera Mining Projects.

<table>
<thead>
<tr>
<th>Project</th>
<th>Mineral Type</th>
<th>Concentrate (Q, '000 ozs)</th>
<th>Price (K/oz)</th>
<th>VC (K/oz)</th>
<th>OC (Km)</th>
<th>Unit Cost (K/oz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pogera</td>
<td>Au (oz)</td>
<td>725</td>
<td>400</td>
<td>290 (.96)</td>
<td>73</td>
<td>88.0</td>
</tr>
<tr>
<td></td>
<td>Ag (oz)</td>
<td>1167</td>
<td>6</td>
<td>7 (.04)</td>
<td>2</td>
<td>1.4</td>
</tr>
<tr>
<td>Misima</td>
<td>Au (oz)</td>
<td>215</td>
<td>400</td>
<td>36 (.93)</td>
<td>23</td>
<td>93.0</td>
</tr>
<tr>
<td></td>
<td>Ag (oz)</td>
<td>857</td>
<td>7</td>
<td>6 (.07)</td>
<td>2</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Notes:
(i) Cu (copper), Au (gold), Ag (silver).
(ii) All values rounded.
(iii) VC (variable cost), OC (operating cost), and Q (quantity, average/year).
(iv) Numbers in brackets are share of VC.
(v) (C) = (A) x (B)
(vi) Total in (D) derived from Placer's estimates.
(vii) (E) = (D)/(Q).

Source:
Calculations based on estimates from:
Placer (PNG) Limited.
Table E-5: Porgera Mining Project: Ore and Concentrate.

<table>
<thead>
<tr>
<th>Year</th>
<th>Ore Milled ('000 tonnes)</th>
<th>Grade (gms/tonne)</th>
<th>Ore Milled ('000 gms)</th>
<th>Concentrate ('000 ounces)</th>
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<td></td>
<td></td>
<td></td>
<td>Au</td>
<td>Ag</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(A)</td>
<td>(B)</td>
<td>(C)</td>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
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<td>30</td>
<td>6000</td>
<td>-</td>
</tr>
<tr>
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<td>40</td>
<td>10000</td>
<td>-</td>
</tr>
<tr>
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<td>350</td>
<td>45</td>
<td>15750</td>
<td>-</td>
</tr>
<tr>
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<td>40</td>
<td>16000</td>
<td>-</td>
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<td>63000</td>
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<td>43200</td>
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</table>

Notes:
(i) Tonnage are calculated from total reserve for the mine and may not exactly represent total tonnage.
(ii) Assuming no silver (Ag) production for the first 5 years.
(iii) 1 oz = 31.1 gms.
(iv) Au (95% concentrate recovery for first 5 years and thereafter 92%), Ag (75% concentrate recovery).
(v) (D) = (A) x (B); (E) = (A) x (C); (F) = (D)/31.1 x .95 (for first 5 years), all other years (F) = (D)/31.1 x .92; (G) = (E)/31.1 x .75.

Source:
Data on total reserve from:
Placer (PNG) Limited.

<table>
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<tr>
<th>Year</th>
<th>GDP</th>
<th>GE</th>
<th>PE</th>
<th>CF</th>
<th>X</th>
<th>M</th>
<th>KI</th>
<th>S</th>
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Notes:
(i) GDP (gross domestic product), GE (government expenditure), PE (private expenditure), CF (government capital formation), X (export), M (import), KI (net capital inflow), S (savings);
(ii) Values from 1960-1972 were in $A million, it is assumed that during this period the kina was at par with Australian dollar as was the case in the two years (1973 - 1975) leading to PNG's monetary independence.

Sources:
(ii) Bank of Papua New Guinea, Quarterly Economic Bulletin, (various years).
(iii) Department of External Territories, Compendium of Statistics, (various years).
Table E-7: Mineral Prices, Exchange Rate and Other Indices.

<table>
<thead>
<tr>
<th>Year</th>
<th>Copper</th>
<th>Gold</th>
<th>Silver</th>
<th>MUV</th>
<th>USDEF</th>
<th>PNGDEF</th>
<th>$US/K</th>
<th>K/$US</th>
</tr>
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Notes:
(i) Copper price ($US/tonne), Gold price ($US/oz), silver price ($US/oz).
(ii) MUV (manufacturing unit value index), USDEF (US GDP Deflator), PNGDEF (PNG GDP Deflator), $US/K ($US to Kina rate), K/$US (Kina to $US rate).
(iii) Before 1975, the A$ was used as currency in Papua New Guinea, thus (A$/US$) was used as exchange rates.

Sources:
(i) Mineral prices and other indices came from World Bank (1985), Tables 6, p. 90.
(ii) Bank of Papua New Guinea, Quarterly Economic Bulletin, (various years).
(iv) International Monetary Fund, International Financial Statistics, (various years).
### Table E-8: Export Price Indices: Selected Commodities.

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**Note:**
(i) Coconut includes coconut oil.

**Sources:**
(i) Bank of Papua New Guinea, Quarterly Economic Bulletin, (various years).

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1969 = 100

Notes:
(i) Indices were derived by dividing the export commodity price indices by the import price index for corresponding years.
(ii) Because of the different data sources and use of different base years, splicing method was used to convert these indices to 1969 as base year.

Sources:
(i) Bank of Papua New Guinea, Quarterly Economic Bulletin.
### Table E-10: Agricultural Commodity Indices for Papua New Guinea, 1969-1983.

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1977 = 100

Notes:
(1) Indices derived by dividing export commodity price indices by the import price index with 1977 as base year.

Sources
Same as Table E-9.
Year | Import | Export | TOT (1969 = 100) | Import | Export | TOT (1977 = 100)
--- | --- | --- | --- | --- | --- | ---
1969 | 100 | 100 | 100 | 110 | 99 | 89
1970 | 99 | 103 | 104 | 108 | 101 | 93
1971 | 97 | 102 | 105 | 144 | 99 | 70
1972 | 90 | 78 | 87 | 98 | 76 | 79
1973 | 91 | 102 | 112 | 99 | 99 | 99
1974 | 105 | 154 | 147 | 116 | 151 | 130
1975 | 132 | 133 | 101 | 147 | 129 | 88
1976 | 85 | 62 | 73 | 94 | 61 | 65
1977 | 91 | 102 | 112 | 100 | 100 | 100
1978 | 93 | 92 | 99 | 103 | 90 | 87
1979 | 103 | 119 | 115 | 113 | 115 | 102
1980 | 114 | 118 | 103 | 126 | 115 | 91
1981 | 124 | 98 | 79 | 136 | 96 | 70
1982 | 131 | 98 | 96 | 145 | 74 | 66
1983 | 138 | 115 | 83 | 153 | 113 | 74

Note:
(1) TOT is Terms of Trade (Export Price Index/Import Price Index).

Sources:
(ii) Bank of Papua New Guinea, Quarterly Economic Bulletin, (various years).
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Discussion Paper No. 23.


Pacific Research Monograph No. 12.


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