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by

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Abstract

The contribution by tree crop industries to economic development in Papua New Guinea (PNG) depends to a considerable extent on their economic efficiency in terms of competitiveness and comparative advantage of domestic production and export marketing. These advantages for the four major tree crop products – coffee, coconut, cocoa, and palm oil – are analysed in this study. The aim is to ascertain whether PNG is an efficient producer of these tree crop exports in terms of international competitiveness and comparative advantage, and whether these industries deserve continuing government support.

Key Words: comparative advantage; competitiveness; devaluation; traded goods; tree crops

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Introduction

Research problem

The contribution by tree crop industries to economic development in Papua New Guinea (PNG) depends to a considerable extent on their economic efficiency in terms of competitiveness and comparative advantage of domestic production and export marketing. These advantages for the four major tree crop products—coffee, coconut, cocoa, and palm oil—are analysed in this study. The aim is to ascertain whether PNG is an efficient producer of these tree crop exports in terms of international competitiveness and comparative advantage, and whether these industries deserve continuing government support.

Tree crop industries in the traded goods sector

PNG is a lower middle-income developing country that has a small and open economy. Its per capita gross national product was equivalent to US$1160 in 1996 (Asian Development Bank (ADB) 1997). Agriculture remains the dominant economic activity in PNG. It provides income, employment and a livelihood for over 85 per cent of the population and absorbs about 40 per cent of formal private sector employment (DAL 1995). It also contributes around one-quarter of GDP and over one-third of export income (World Bank 1997).

The economic performance of the traded goods sector of a country[1] is obviously of great national importance (Warr 1992). Tree crops and mining products are the major exports in PNG. Coffee, cocoa, coconut products[2] and palm oil contributed K538 million to export earnings during 1996 which was 95 per cent of agricultural exports, 50 per cent of natural resource exports and 16 per cent of total exports. Export income from coffee is about K190 million, followed by palm oil and palm kernel oil (K182 million), copra (K49 million), coconut oil (K51 million) and cocoa (K66 million) (Department of Finance 1997).

Smallholders produce about 75 per cent of tree crop exports (DAL 1995) and are the main target of government policy (World Bank 1997; Setae 1994). Some 468 000 households (about 80 per cent) of the estimated 574 000 households in PNG produce these crops. The tree crops sub-sector is therefore crucial for economic development in general, and smallholder agriculture in particular. The Department of Agriculture and Livestock (DAL) considers its revitalisation a planning priority, to be achieved primarily by improving profitability and competitiveness (DAL 1995; Setae 1994) in the context of recent economic reforms aimed at ensuring economic efficiency, among other things. The centrepiece of these reforms is a structural adjustment program that is beginning to have widespread impacts across the economy, including the rural sector. Most of the reforms are directed towards improving the competitiveness of industries in the traded goods sector, with special emphasis on the tree crops sub-sector and macroeconomic stability. The challenges

[1] Tradeables comprise 'goods and services whose use or production causes a change in the country's net import or export position' (Perkins 1994, p. 145). Tradeable outputs either are exported or substitute for other goods that are exported, and importables, which substitute for imports. Tradeable inputs are imports or substitutes for imports, and exportables, which are inputs that could have been exported had they not been used as inputs in domestic production (Perkins 1994, p. 150).

[2] Copra and coconut oil are the two most important of many coconut products.

facing the tree crops sub-sector in PNG include developing mechanisms for maintaining comparative advantage and international competitiveness.

Policy intervention

Any industry assistance policy should be considered only if the industry is efficient, or if there are steps that the government could take to enable it to be efficient. In a market economy, most economic reforms focus on setting the right prices, and minimising trade barriers and market distortions. They are based on the premise that trade barriers to protect inefficient traded and non-traded goods sectors ultimately diminish economic welfare. Assessment of the comparative advantage and competitive advantage in the production of traded goods should facilitate policy reform, thereby aiding decision making in resource allocation and planning trade policy.

One of the main aims of policy intervention in the form of industry support is to increase economic efficiency, and economic policy analysis for any sector or industry must first entail an analysis of its efficiency. The purpose of such analysis is to measure the contribution by each economic activity to economic growth. In the present study, the efficiency of the tree crop industries, termed collectively the tree crops sub-sector, is first evaluated before undertaking policy analysis.

Price manipulation has been a major area of policy analysis in PNG, encompassing mainly price stabilisation and price support. Newbery and Stiglitz (1981) remarked that specialists in traditional trade theory had long expressed uneasiness with the analysis of trade as an alternative method of stabilising commodity prices on the grounds that it ignores the principle of comparative advantage. It is essential, therefore, to evaluate the comparative and competitive advantage of tree crop exports along with an evaluation of price variability.

The real exchange rate is an important factor influencing international competitiveness (ADB 1993b), and manipulation of the exchange rate has been a popular policy tool for the government in PNG. A fixed exchange rate was in place from independence in 1975 until a floating exchange regime was introduced in October 1994. During this period, the nominal exchange rate for the Kina fell until 1990 but the real exchange rate appreciated. This appreciation rendered the non-mining export sectors less competitive and discouraged the use of domestic resources, including labour. Since 1994, the Kina has been pegged to a basket of currencies of the major trading partners of PNG. The currency value was distorted under both regimes due to various trade protection barriers. The impacts of devaluation on competitiveness and profitability of the tree crop industries need to be evaluated under the new exchange rate policy.

Public research and development policy has been another key policy area of government assistance to develop the tree crop industries. The introduction of improved technologies offers the possibility of higher productivity and reductions in the unit cost of production, thereby improving the competitive position of firms in the tree crop industries and the comparative advantage of these industries as a whole. The major research institutions are the Cocoa and Coconut Research Institute of PNG, Coffee Research Institute and PNG Oil Palm Research Association.

Scope of the study

Farm production and the point of export are the focal points for the analysis of comparative advantage and competitiveness, concentrating on smallholder farm models. First, measures of private and economic profitability are calculated to assess the efficiency of smallholder tree crop production and of the tree crop industries in general. The concepts of competitive and comparative advantage are applied as measures of private and economic profitability, respectively. Comparative advantage measures indicate the efficiency of resource allocation at the national level, and competitiveness measures the efficiency of commercial activities of individual producers and firms in the international markets. Results should reveal whether PNG is an efficient producer and exporter of each of the tree crops. The extent to which commodity price fluctuations affect competitiveness is also measured, along with the impact of devaluation on each industry in the tree crops sub-sector.

Competitiveness and comparative advantage are measured using two alternative methods: the benefit-cost ratio (BCR) and domestic resource cost (DRC) ratio. The market price ratios reveal the private profitability at the producers' and exporters' levels. The shadow price ratios reveal the economic or social profitability at the same levels.

Review of Studies of Comparative Advantage and Competitiveness

Comparative advantage

The principle of comparative advantage has been central to trade theory, demonstrating the gains from, and direction of, trade. If every country specialised in the production and export of goods in which another country is a relatively high-cost producer, both global welfare and the welfare of each trading country would be maximised.

Measures of comparative advantage are among the most useful guides to optimal resource allocation in an open economy such as PNG where international trade is vitally important. Economists have been applying the principles of specialisation and comparative advantage to explain the theory of international trade for which the concepts of relative cost and price differences are basic. The production and export of traded goods, including tree crop exports, are normally guided by the international differences in costs of production and prices of products measured in terms of comparative advantage and international competitiveness. The doctrine of comparative advantage has been one of the most powerful influences on economic policy making and international trade in recent history. A country 'has a comparative advantage over another if in producing a commodity it can do so at a lower opportunity cost in terms of the foregone alternative commodities that could be produced' (Todaro 1989, p. 617). Economic planning involves identification of the sources of comparative advantage and international competitiveness, among other things, in a dynamic world.

The Ricardian and Heckscher-Ohlin doctrines of comparative advantage (Ohlin 1933) have been powerful influences on economic policy making and international trade. The classical theory of comparative advantage was developed by Ricardo to assess the economic efficiency of resource allocation in the production of traded goods. He considered only one primary factor, labour, to explain variations in labour productivity among industries and between countries as the main source of comparative advantage.

According to the Heckscher-Ohlin doctrine, there are no variations in the production function between countries and each country has a comparative advantage in those industries that intensively use domestic factors available in abundance (Warr 1992). The Heckscher-Ohlin neoclassical model of international trade and the Heckscher-Ohlin-Samuelson model (Samuelson 1949) include more than one primary factor. The Heckscher-Ohlin model is based on factor endowments (Leamer 1984; Thomas 1988) and does not recognise influences such as technical change on the productivity of factors of production. Some countries, such as Japan, have been successful in world trade with very limited factor endowments but with great productivity improvements.

The development by Balassa (1965) of the 'revealed comparative advantage' model, and its subsequent extension (Balassa 1978) to encompass a 'stages' approach to industrialisation, was a major innovation. For a particular country, the revealed comparative advantage in a product is defined as the ratio of the share of that product in world trade. If this index takes a value greater than unity, the country is considered to have a revealed comparative advantage in the product while a value below unity indicates a comparative disadvantage (Yeats 1989).

Selected empirical and theoretical studies of comparative advantage

A useful starting point to review empirical and theoretical studies of comparative advantage is the apparent anomaly observed by Leontief (1966). Contrary to relative factor endowments, United States exports appeared to be labour-intensive and Indian exports were capital-intensive. This was probably due to the relative service intensity of exports from USA and India. US exports were thought to acquire a competitive edge from their efficiently supplied intermediate services. Hufbauer (1970) was the first to distinguish between the neo-factor proportions and neo-technological explanations of comparative advantage. In the former, human capital is combined with physical capital and (unskilled) labour. The latter emphasises the role of technological change, the product cycle and economies of scale in determining the pattern of international specialisation.

The traditional concept of comparative advantage thus has to be broadened to include the concept of human capital as well as physical capital, because countries do not have to accept their 'original' resource endowment. According to Schuh (1990), investment policy designed to augment and shape a nation's stock of human capital is a more viable way to alter and improve its comparative advantage than protectionist measures, which distort resource use and reduce the ability to compete in the international economy.

Goodman and Ceyhun (1976) found that the variables describing different facets of the technology phenomenon are singularly the most important variables in defining comparative advantage, suggesting that the neo-technology hypothesis is important in explaining international trade in manufactured goods. Based on empirical studies, Balassa (1977) concluded that inter-country differences in the structure of exports are in large part explained by differences in physical and human capital endowments. His results lend support to the ‘stages’ approach to comparative advantage, according to which the structure of exports changes with accumulation of physical and human capital.

Krueger (1978) stated that we do not know enough about the determinants of comparative advantage to be able to forecast in a multi-country world which country would export which commodities. For instance, Balassa (1981) referred to a remark by Professor Paul Samuelson that manufacturing industry was trying to leave North America and Western Europe as comparative advantage was shifting to South Korea, Taiwan, Hong Kong and Singapore. He held the view that trade liberalisation and an outward-oriented strategy would permit shifts in world trade to take place in accordance with the changing pattern of comparative advantage without involving excessive adjustment costs. Factor abundance, trade policies, technological upgradation and innovations would all contribute to this change.

Deardorff (1984, pp. 19-20) referred to services provided internationally by transnational firms where some factors of production are specific or unique, such as better management and a proprietary product or brand name. There it is more difficult to reconcile trade with comparative advantage. He added that when comparative advantage results from differences in technology rather than differences in factor endowments, it requires a reinterpretation of trade in a way that interferes considerably with the usefulness of comparative advantage as a guide to empirical reality, which actually makes matters worse. He felt that the principle of comparative advantage might not be as robust as many, including himself, had thought. Although the concept was originally developed to explain the relationship between factor endowments and trade, that did not preclude the measurement of comparative advantage due to other factors. In fact, data used to estimate benefits and costs for comparative advantage normally reflect the quality of technology and management. Again, a brand or product name is earned because of the best quality of resources used and the efficiency of resource use. Comparative advantage need not be based on low cheap domestic resources alone; it can also be achieved because of market innovations and higher productivity of factors.

Trade and investment in services are presumably determined by the same influences that shape comparative advantage in goods, namely factor endowments, technology and government policies. Yet Tucker and Sundberg (1986) argued that models of comparative advantage have failed to account adequately for international trade in services by inadequately considering three characteristics of an economy relevant to the supply side. First, the size and structure of the domestic service sector is broadly indicative of an economy’s underlying strength and specialisation in the supply of services, including economies of scale. Second, the ratio of intermediate to final service output suggests the pattern of specialisation, so that a high proportion of intermediate industrial services in the domestic economy suggests comparative advantage in direct export of those goods and services that use these services intensively in their production process. Third, the degree of dependence on trade (the proportion of domestic output exported) depends in turn on the structure of production and extent of natural and artificial barriers to trade, thereby affecting the magnitude of service flows.

These arguments are valid so long as the prices of traded and non-traded goods and services used in the production of exports are not affected by domestic economic conditions. In reality, the impacts of all these factors—economies of scale, pattern of specialisation and degree of dependence on trade—are fully reflected in costs and prices in the economy that in turn affect comparative advantage.

Tucker and Sundberg (1986) suggested that the measurement of comparative advantage using observed trade data should take demand-side factors into consideration. Barriers to trade and the characteristics of export markets may distort the pattern of trade dictated by comparative advantage. The distinction between directly and indirectly traded services also has implications for comparative advantage in merchandise trade. The efficiency of the domestic service sector in supplying intermediate industrial services (for example, financial, distribution or research and development services) may be one factor determining comparative advantage in traded goods. Services cannot be considered 'factors' of production; however, in so far as they resemble factor 'embodiment' through the cost structure (unlike material inputs, they are intangible), service intensity may be examined much as labour or capital intensity. Two issues are raised here. First, trade barriers and market distortions affecting services can indirectly influence the comparative advantage of traded goods. Second, service intensity and the inefficient supply of intermediate services can also affect comparative advantage in traded goods.

Jabara and Thomson (1980) studied comparative advantage in the agricultural sector in Senegal under international price uncertainty. They showed that the pattern of comparative advantage was less clear-cut when the price and yield uncertainties were considered. They also indicated that comparative advantage was influenced by the relative weights planners attach to risk from different sources. Comparative advantage is a static concept but its measure is variable: it changes according to changes in market signals and the adoption of new technologies, among other things. This is evidently not a problem with the concept but with the input data and method used to test the sensitivity of measures. However, it suggests the need for careful processing of input data and adoption of methods to ensure conceptually appropriate results.

Helpman and Krugman (1985, p. 261) evaluated the impact of market structures and attributes of industries using the Heckscher-Ohlin model. They concluded that the theory of comparative advantage is alive and well, but it has lost its monopoly position. Even with economies of scale and imperfectly competitive markets, differences in the characteristics of countries are a major predictor of patterns of trade for a variety of market structures. The theory of comparative advantage that was based on factor endowments as the reason for comparative advantage certainly has lost its monopoly but the basic concept continues to dominate the theory.

Competitiveness or comparative advantage?

Recent developments in international trade, with firms in newly industrialising countries emerging as industrial giants, reinforce the continued importance to governments of understanding competitiveness as well as comparative advantage. Competitiveness indicates which firms within or across countries could better compete in international markets under certain assumptions about existing marketing systems and government interventions.

Warr (1994) noted that the decision to compete in the production and trade of export commodities is generally guided by two parameters: comparative advantage, which is measured in shadow prices, and competitiveness, or competitive advantage, which is measured in market prices. Comparative advantage indicates whether it is economically advantageous for a country to expand production and trade of a specific commodity. It is a concept that applies to inter- and intra-industry comparisons within a country in the traded goods sector, but is inappropriate for inter-country comparisons. Competitiveness indicates whether a firm or set of firms could successfully compete in the trade of the commodity in the international markets given existing policies and economic structure.

Porter (1990) used the doctrine of comparative costs to explain comparative advantage and competitiveness. Theoretically, he noted that it depends on three factors: a highly competitive macroeconomic environment; innovative capacity to develop and adopt technology to reduce production costs, and diversify and differentiate products; and competitive marketing. Warr (1994) disagreed with this explanation and argued that the two concepts are not the same, and any attempt to portray them as being the same, or at least similar, is misleading. Competitiveness is determined by the commercial performance of individual firms whereas comparative advantage is about efficient allocation of resources at the national level, especially among the sectors of the economy producing traded goods and services. The first is about firms, the second about countries. The concept of comparative advantage is most relevant for nations that are currently producers of primary products and standardised manufactured goods, while the concept of competitiveness has most to offer individual firms that produce differentiated products and goods and services sold in specific market segments.

Competitiveness and comparative advantage would be the same in a world of perfect competition in which there are homogeneous products, perfect information and an absence of market failure. In the real world, however, the two indicators typically diverge because of distortions in input and product marketing systems, often associated with direct and indirect government intervention. It is important to calculate both measures and to identify the reasons for divergences.

Divergences arise from distortions in:

- market prices of outputs, due to events in the economic environment and trade regimes;
- prices of factors used in production;
- prices of factors used in marketing and processing activities that influence marketing margins;
- interest rates; and
- the exchange rate.

Cases where comparative advantage and competitiveness diverge may represent opportunities for policy dialogue. Revealing these distortions and their sources can open up possibilities to improve both measures (ADB 1993a).

Porter (1990) argued that in a world of high technology and global competition, explanations for competitiveness such as cheap and abundant labour and bountiful natural resources, favourable exchange rates and export incentives may enter the picture but are not the crucial answers. Innovation and technological upgradation, he claimed, are essential to maintain competitiveness on a continuing basis. Only where there is uniformity of innovation and upgradation among the trading nations are factor abundance, competitive factor and product markets and the economic policy environment crucial to maintaining competitiveness. In this respect, like comparative advantage, competitiveness is increasingly influenced by the quality of human capital available to firms.

Han (1991) expressed the view that international competitiveness depends heavily on the stability of the macroeconomic environment. Macroeconomic tools such as exchange rates and interest rates are important factors determining the price aspects of international competitiveness. For example, price stability and equilibrium exchange rates are generally regarded as essential macroeconomic conditions for strong international competitiveness. Other macroeconomic factors such as fiscal policy, political stability and industrial relations also affect the competitiveness of an industry in the international market. The government is primarily responsible for ensuring favourable macroeconomic conditions. On the other hand, the more direct factors affecting international competitiveness are microeconomic in character. One set of such factors obviously influence the cost of production but other marketing and management factors can also be important, influencing things such as the quality of products. These factors are determined at the level of the firm and its plants where the actual strategic and tactical management decisions are made and production processes take place. This implies that the private sector is primarily responsible for ensuring the smooth working of the microeconomy.

Comparative advantage and competitiveness in PNG

It is government policy in PNG to revitalise and rehabilitate the tree crops sub-sector (DAL 1995). Various studies by multilateral funding agencies indicate considerable scope for improving the comparative advantage and competitiveness of industries in this sub-sector.

Both the World Bank and ADB have in the recent past cast doubts about the comparative advantage and competitiveness of tree crops export industries in PNG. The World Bank (1994) asserted that PNG is a high-cost agricultural producer and its major export crops are not competitive in the international market. ADB (1993a, 1993b) maintained that a major reason for the poor performance of PNG in employment generation since independence is a lack of international competitiveness in the non-mining sector. PNG, it asserted, is a high-cost producer of export commodities and import substitutes, causing a lack of viable investment and low rates of economic growth. It concluded that the most fundamental development challenge for PNG in the 1990s is to overcome this lack of competitiveness.

DAL (1995) also observed that serious cost pressures had made PNG relatively uncompetitive in agricultural exports, and had led to virtual stagnation in agricultural production. External funding of programs in the tree crops sub-sector has been very limited in the past five years due to the controversy over unsustainable price support and concerns about a lack of competitiveness of the tree crop industries.

The World Bank (1992) explained lack of competitiveness in terms of structural and macroeconomic factors. The structural factors include:

- institutional rigidities in the labour market;
- weak infrastructure to support private sector development;
- an under-developed educational system;
- policy-induced price distortions;
- poorly defined property rights to land;
- a regulatory rather than promotional approach to new investment;
- a financial system of limited depth; and
- low enforcement of law and order.

Factors 2, 3, 4 and 8 are very powerful in affecting competitiveness. Factors 1, 5, 6 and 7 might not directly affect competitiveness but they adversely affect general development initiatives.

The World Bank (1994) felt that high levels of real wages and rigidity in the labour market plus a high real exchange rate are the most important macroeconomic factors making PNG uncompetitive in international markets for its major export crops. Some economists (e.g. Jarrett and Anderson 1989; ADB 1993a) blamed the hard currency policy for the poor performance of the agricultural sector. Pragma Corporation (1991) suggested exchange rate devaluation as one of the options to improve incomes and competitiveness in the tree crops sub-sector. Since these assessments, devaluation of the Kina and the subsequent introduction of a floating exchange rate regime have improved the competitiveness of the traded goods sector, as has the liberalisation of wages policy. The competitiveness of the tree crops sub-sector needs to be re-assessed under this new policy regime. The way in which the floating exchange rate influences comparative advantage and competitiveness is taken up in the next section.

PNG is often characterised as a country that has high costs and inefficiency in non-traded inputs that are used in significant quantities in the provision of services. Inputs such as transport, power, telecommunications, distribution and unskilled labour are used in the processing and marketing of tree crop products, and are thought to diminish considerably the comparative advantage of their industries.

Kannapiran (1993) and Kannapiran, Togiba, Taporaie and Kendica (1993) estimated the comparative advantage and competitiveness of rice and rubber production, respectively, in PNG. Their findings suggest that the advantages gained at the farm level are lost during processing and marketing. They also found a wide gap between the two measures that they suggested was due to high levels of distortions and inefficiency in the domestic economy, mainly due to the inefficient non-traded service sector.[3]

[3] This explanation is fallacious because inefficiency should not cause a divergence between competitiveness and comparative advantage.

Peter (1997) studied the sugar industry in PNG, and concluded that a substantial comparative disadvantage existed in sugar production and processing.

Comparative advantage and competitiveness with a floating exchange rate

The exchange rate, as the relative price between tradeables and non-tradeables, is an important determinant of the allocation of resources in an economy. Any departure from the equilibrium exchange rate or exchange rate uncertainty might retard export growth. An overvalued currency contributes to a loss of competitiveness of tradeables and a contraction of the non-tradeables sector (Steinherr 1985). Some countries try to solve their cost problems via structural adjustment while others try to solve their structural problems through cost adjustments. The optimal policy, according to Soderstrom (1985) is to restore the real exchange rate to its equilibrium level and carry out structural adjustment within the tradeables sector.

Attainment of an equilibrium exchange rate and currency stability should be possible in countries with a strong foreign exchange market, high investment rating of country risk and capital mobility. These conditions are not fulifilled in PNG, however, and experiences so far indicate that currency instability is causing serious problems in the economy (Kannapiran and Wosae 1995).

A chief purpose of devaluation is to increase the relative prices of domestically produced traded goods to non-tradeables in order to promote export production. The Kina tended to appreciate against the currencies of the major trading partners of PNG after the 1990 devaluation, reducing the competitiveness of exports. Woldekidan (1994) argued that the nominal exchange rate should be depreciated to discourage imports by increasing their prices. However, most production and consumption activities in PNG depend heavily on imported inputs. It is therefore difficult to say that competitiveness would improve by devaluation. Exchange rate-linked inflation of about 30 per cent (Kannapiran and Wosae 1995) might have adversely affected the prices of domestic inputs such as transport, electricity, infrastructure maintenance and, to some extent, labour even though wages had been liberalised.

Zeitsch, Fallon and Welsh (1993) studied the impacts of an increase in the real exchange rate on the non-mineral sectors in PNG, using a computable general equilibrium model of PNG constructed by the National Centre for Development Studies (Vincent, Weisman, Pearce and Quirke 1991). Their results suggest a considerable reduction in competitiveness in tradeables, with a decrease in the volume of exports and an increase in the volume of imports.

Estimation Techniques for Comparative Advantage and Competitiveness

Comparative advantage and competitiveness reveal the relative efficiency of an activity in saving foreign exchange through import substitution or earning it through exports. Maximum efficiency in balancing the foreign exchange budget means doing so at least cost in the social value of resources used. Accordingly, if one activity costs less in domestic resources to save or earn a unit of foreign exchange at the margin than another, the former is advantageous in relation to the latter. Thus, activities can be ranked at the margin according to their competitiveness or comparative advantage. Choosing an activity with a greater comparative advantage means reducing the social cost of balancing the foreign exchange budget (ADB 1993a; Warr 1992).

There are two main methods to measure the comparative advantage and competitiveness of producing and exporting tree crop commodities: the DRC approach and benefit-cost analysis. These methods have the same foundation but differ in their capacity to interpret the results.

According to Masters and Winter-Nelson (1995, pp. 243-4):

> Most analysts consider it sufficient to note that various indicators produce identical criteria for distinguishing between comparative advantage and disadvantage. But policy makers often need to use indicators to rank alternative activities, or to identify a single most desirable activity. Such rankings are not relevant in traditional trade theory, which implies that all desirable activities should be simultaneously expanded until further expansion is no longer desirable. But in many applications, policy makers cannot pursue all goals simultaneously. They therefore need priority rankings as well as a yes/no criterion.

One approach is to report different measures of comparative advantage and competitiveness in a summary table and compare their decision outcome for each crop and rankings among crops. An alternative approach is to include DRC ratios only, and report where any of the other measures diverge from them in respect of the rankings among the activities. In the present study, the DRC ratio and the BCR—a commonly used criterion in benefit-cost analysis that is closest in structure to the DRC ratio—are used to reveal the competitiveness and comparative advantage of tree crop activities.

Two other criteria are commonly used in benefit-cost analysis: the internal rate of return (IRR) and the net present value (NPV). The IRR is specifically termed a financial rate of return (FRR) in a financial analysis and economic rate of return (ERR) in an economic analysis. The FRR and ERR measures are also estimated in this study but, following Masters and Winter-Nelson (1995, p. 244), the NPV criterion is not used because it is not a unit-free measure.

The scope for differences in results between the methods commonly used in benefit-cost analysis has been well canvassed by a number of analysts (e.g. Scandizzo and Bruce 1980; ADB 1993b; Masters and Winter-Nelson 1995), and it is not proposed to enter this debate in this study. The debate between the DRC methods and the methods used in benefit-cost analysis continues, however, and the empirical evidence from this study is used to examine whether the two sets of measures provide similar results in terms of rankings. The comparison is principally drawn between the DRC ratio and the BCR because of their similar structures as unit-free measures.

Sensitivity analyses are carried out by changing the price of a tree crop output.[4] The switching-value method (Gittinger 1982) is used to calculate break-even prices that indicate the output price level above which advantage is achieved.

Scandizzo and Bruce (1980) were of the view that the main determinants of the DRC ratio and BCR are relative yields and relative border prices where land and labour requirements for different crops within specific areas do not vary substantially. In such cases, the analysis of comparative advantage or competitiveness can be simplified by comparing the border prices multiplied by the yield for each crop. However, in measuring comparative advantage or competitiveness, they indicated that the BCR is probably preferable to the DRC ratio. First, it conforms to the World Bank's own evaluation method for projects. Second, it is simpler to estimate and less arbitrary in that one does not have to worry about which items to put in the numerator and which in the denominator. Third, from a practical point of view, the definition of the DRC ratio suffers from the problem that it is not always clear which are domestic resources and which are foreign resources.

Two of their arguments—that the BCR is simpler to estimate and less arbitrary in that one does not have to worry about which items to put in the numerator and denominator (see also Masters and Winter-Nelson 1995)—are not entirely true. In both methods, the traded items—in foreign resource costs (FRCs)—and non-traded items (DRCs) are segregated and valued at market and shadow prices to estimate both the DRC ratio (ADB 1993a; Warr 1992) and BCR (Gittinger 1982; Ward, Deren and D'Silva 1991). Both methods involve the same level of complication in treating DRCs and FRCs, and they use the same set of data, but the results are in different forms of measurement.

Masters and Winter-Nelson (1995) studied the Kenyan agricultural sector and demonstrated that the DRC ratio method is biased against production that relies heavily on domestic resources. Their argument was based on the assumption that dependence on domestic resources will be always cheaper. In most developing countries with distorted markets and trade barriers, domestic resources are costlier than traded inputs (Gonzales 1984). In this situation, there is a wide gap between competitiveness and comparative advantage, and failure to measure and account for market distortions might lead to biases. That must be the case under both methods. The DRC method is based on the principle of exchange rate through a particular commodity. In an open economy with frequent external balance problems, the rate at which the domestic resources are converted into foreign exchange for a given level of official exchange rate (OER) or shadow exchange rate (SER) is crucial. This link between primary commodity exports and the exchange rate relates to the important role of the traded goods sector in achieving macroeconomic growth and stability. The DRC ratio estimates are used for discussion purposes in the present study, but the BCR estimates are also furnished for comparison. The idea is to reinforce the findings beyond suspicion about model-specific results.

Gonzales, Kasryno, Perez and Rosegrant (1993) measured comparative advantage in the production of food crops in the Philippines by comparing the border price with the social or economic opportunity costs of producing, processing,

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[4] The effect is equivalent to changing yields, and thereby quantity, by the same proportion because tree crop export income is the product of price and quantity.

transporting, handling and marketing an incremental unit of the food commodity. If the opportunity costs are less than the border price, then that country has a comparative advantage in the production of that commodity. They used three indicators of comparative advantage: net social worth, the DRC ratio and the resource-cost ratio.

Greenaway, Hassan and Reed (1994) undertook an empirical study of comparative advantage in Egyptian agriculture. They used two methods, the BCR and the DRC ratio.

Benefit-cost analysis criteria

The main benefit-cost analysis criterion used in this study, the BCR, is based on standard financial and economic benefit-cost analysis used extensively in the analysis of policies and projects. Its attributes have been discussed by, among others, Squire and van der Tak (1975), Gittinger (1982), Little and Mirrlees (1982) and Ward et al. (1991). It is a measure of financial and economic efficiency using a time-collapsed form.

The financial benefit-cost ratio (FBCR) that reveals competitiveness is calculated using market or financial prices to value costs and benefits. The social (or economic) benefit-cost ratio (SBCR[5] or EBCR) that reveals comparative advantage is estimated using shadow or economic prices to value costs and benefits. The BCR is estimated by dividing the present value of all benefits by the present value of all costs, expressed in domestic currency.

The BCR models used to estimate competitiveness and comparative advantage are furnished in equations (1) and (2), respectively. The FBCR is estimated as:

$$\left(\sum_{t=1}^{n}\frac{p_m}{(1+r)^t}\right)\div\left(\sum_{t=1}^{n}\frac{f_m}{(1+r)^t}+\frac{d_m}{(1+r)^t}\right) \qquad (1)$$

where d_m and f_m are, respectively, domestic and foreign resource costs per unit of production in market prices expressed in foreign currency; p_m is the actual f.o.b. export price per unit of output in foreign currency; and r is the discount rate.

The EBCR is estimated as:

$$\left(\sum_{t=1}^{n}\frac{p_s}{(1+r)^t}\right)\div\left(\sum_{t=1}^{n}\frac{f_s}{(1+r)^t}+\frac{d_s}{(1+r)^t}\right) \qquad (2)$$

where d_s and f_s are, respectively, domestic and foreign resource costs per unit of production in shadow prices expressed in foreign currency; and p_s is the f.o.b. export price per unit in foreign currency and in shadow prices.

In both equations, the foreign and domestic resource costs are shown separately to indicate the relationship between the BCR and DRC ratio. However, when

[5] No distinction is made between social and economic efficiency in this study although such a distinction is commonly made in the literature (e.g. Squire and van der Tak 1975). The most obvious difference between the two concepts arises when trying to account for income distribution effects which are incorporated in a measure of social efficiency. There are also other social factors that could be incorporated in a study that makes the two concepts different. In this study, lack of data on distributional and other social issues means that the analysis is concerned solely with economic efficiency.

estimating the BCR, the total cost can be considered as the denominator as it is not necessary to distinguish between the domestic and foreign resource costs.

The DRC method

The DRC method was developed simultaneously by Bruno (1967) and Krueger (1966). It measures the gain from expanding profitable projects and the cost of maintaining unprofitable activities through trade protection. The DRC ratio criterion has been extensively used in policy analysis by, among others, ADB (1993a), IFPRI (Gonzales et al. 1993), OECD (Alpine and Pickett 1993), CIMMYT (Morris 1990), FAO (Appleyard 1987) and the World Bank (1991).

Market prices and exchange rates are used to calculate the financial DRC ratio. The shadow or accounting prices of domestic resources used in the production of a tradeable output are used to calculate the social value of DRCs. The DRCs are then compared with the accounting or shadow prices of foreign exchange earned or saved through the production of the tradeable to calculate the social DRC ratio.

Warr (1992) interpreted the DRC ratio in two ways. First, the DRC ratio of industry j gives the proportion by which the international price of traded good j, p_j, must be changed for industry j to be one of the tradeable industries that would survive under free trade. If this proportion is smaller than unity, the country possesses a comparative advantage in good j; if it is greater than unity, it does not. Second, tradeable items are measured in foreign currency and the non-tradeable or primary factors in shadow prices in domestic currency units. The ratio of these units of measurement can be thought of as the shadow price of foreign exchange. The DRC ratio for a particular industry indicates the proportion by which the shadow price of foreign exchange must be multiplied for that tradeable goods industry to break even in shadow prices.

According to Warr (1992), the DRC ratio is a measure of the social cost to the nation of the resources—land, labour and capital—required by a particular industry to earn one unit of foreign exchange. The measure takes account of the degree to which domestic commodity prices have been altered by the structure of tariffs and import quotas, and the degree to which the domestic market prices of primary factors differ from their social opportunity costs. When the DRC ratio differs between industries, it indicates the way resources could be allocated among industries to increase foreign exchange earnings.

The DRC ratio is measured by first estimating the value of domestic factors of production and inputs, or DRCs, converted from domestic to foreign currency units (the numerator). The DRCs are then divided by the net foreign exchange earnings, or savings per unit of domestic production of the tradeable—income from the tradeable less the FRCs used in its production, in foreign currency (the denominator). The net foreign exchange earned is the f.o.b. export price in foreign currency minus the foreign currency value of imported or diverted exports used in the production of a unit of the tradeable.[6]

When there is neither competitiveness nor comparative advantage, domestic production would be more costly than imports and domestic resources would be misallocated. In that circumstance, competitiveness and comparative advantage

[6] Values could also have been expressed in domestic currency units.

serve as indicators of possible distortions in the economy caused by trade protection and misdirected trade policy.

According to Helpman and Krugman (1985), the DRC ratio is the market or shadow value of non-tradeable factor inputs used in an activity per unit of tradeable value added in market or shadow prices. It can also be expressed as the ratio between the cost of a dollar earned or saved through domestic production and a market or shadow rate of exchange. We term this the exchange earning rate, which is in effect the 'own exchange rate' of the activity or the rate at which domestic resources can be converted into foreign exchange through the production of the tradeable output. If the exchange earning rate in market prices is less than the OER (domestic currency per unit of foreign currency, or K/US$), there is competitiveness in domestic production. If the exchange earning rate in shadow prices is less than the SER in K/US$, there is comparative advantage in domestic production.

The models used to estimate the exchange earning rates for commodities are furnished in equations (3) and (4). For competitiveness, it is the market price DRC ratio over the OER:

$$\left(\sum_{t=1}^{n}\frac{d_m}{(1+r)^t}\div\left(\left(\sum_{t=1}^{n}\frac{p_m}{(1+r)^t}\right)-\left(\left(\sum_{t=1}^{n}\frac{f_m}{(1+r)^t}\right)\div a\right)\right)\right)\div a \qquad (3)$$

where a is the OER in Kina per US dollar.

For comparative advantage, the shadow price DRC ratio is divided by the SER:

$$\left(\sum_{t=1}^{n}\frac{d_s}{(1+r)^t}\div\left(\left(\sum_{t=1}^{n}\frac{p_s}{(1+r)^t}\right)-\left(\left(\sum_{t=1}^{n}\frac{f_s}{(1+r)^t}\right)\div b\right)\right)\right)\div b \qquad (4)$$

where b is the SER in Kina per US dollar.

The current study follows the ADB recommendation that the DRC ratio represents the best choice for analysis, for three principal reasons (ADB 1993b). First, it is the most widely used measure of comparative advantage, especially in developing countries (see also Warr 1992), and is thus useful for purposes of comparison. Second, its wide use may reflect the fact that, owing to circumstances or often policies, foreign exchange limitations do indeed represent a severe constraint on development in countries such as PNG. Finally, the DRC ratio is the relevant measure if we make domestic resources in the aggregate the principal constraint. For this reason, it is a more general criterion than are others.

Limitations of the DRC method

The DRC method measures only static efficiency and fails to account for the dynamics of price and quantity changes in input-output relations (ul Haque 1991). Capturing the market dynamics is a generic problem to most economic analysis, including benefit-cost analysis, and is not something specific to the DRC method alone. This problem can be solved to some extent by carrying out sensitivity analyses, as usually done with benefit-cost analyses, by testing the sensitivity of the estimates at varying levels of prices and quantities of inputs and outputs, and exchange rates.

The DRC method does not inform the analyst by how much one activity should be substituted for another to increase economic efficiency. The existence of diminishing returns to factors of production in agricultural activities suggests that the extent of substitution should not be boundless.

Further, the DRC criteria should be estimated for various production systems and at different levels in the production and marketing systems—production, processing and marketing levels. Countries exporting tree crop commodities face almost the same international prices for their commodities; but the costs of production and internal structure of costs (considerably influenced by production relations) are unlikely to be the same for all of them. The same is true for firms or farmers producing exports within the country. In theory, it is possible to estimate DRC ratios for groups of producers or sections of an industry facing different physical and technical conditions in which to produce. In practice, however, it is very difficult to satisfy the data requirements of these measures. One outcome of this for the present study is that a very strong assumption is made that all smallholders in an industry operate in exactly the same as each other and produce a homogeneous product. That is, if one producer has a competitive advantage in producing a crop, then so do other producers in that industry.

Finally, the DRC method has been criticised for emphasising foreign exchange market distortions at the expense of others. Ali (1986) argued that it is one of a number of alternative measures, and economists would do well to use a variety of available methods to satisfy their information needs.

Estimation of Comparative Advantage and Competitiveness in PNG

Estimation procedure

Estimation of the criteria for competitiveness and comparative advantage mentioned above was undertaken for the individual tree crop commodities of cocoa, copra, coffee and palm oil. Farm models were developed for each crop using activity budgeting (Gittinger 1982) (see Kannapiran (1999, Appendix 1). All tree crops except oil palm are parts of different tree crops-based farming systems, which suggests that whole-farm modelling should be preferred to activity budgeting. This may be more appropriate for a broader rural sector policy analysis but the sole concern is with tree crop exports in the present study. Hence, activity budgeting is considered adequate for this purpose.

Some of these activities entail the production of multiple outputs, notably coconuts which have many end products but particularly copra and coconut oil, and oil palm which has two major end products in palm oil and palm kernel oil. In these cases, the major export product is considered as the final product for the purposes of the analysis, namely copra in coconut production and palm oil in oil palm production. The implied assumption is that the whole industry is efficient if production of the major export product is efficient. This may not be the case with coconut production because the milling of coconut oil is a vastly different process from the production of copra.

There are two critical points in the production and marketing process where measurement of comparative advantage and competitiveness can be made: one at the farm gate, covering production only, and the second at the point of export, which includes processing and marketing as well as production. Estimation at the latter point enables the evaluation of a broad spectrum of activities. At the farm level, benefits are estimated as the farm gate price times quantity produced. After processing and marketing, or at the point of export, they are estimated as the f.o.b. export price times the quantity exported. The costs of production include the farm-level production costs plus the processing and marketing costs. Processing and marketing are undertaken by private sector companies in the coffee, cocoa and oil palm industries. Copra processing is undertaken mainly by the smallholders themselves while the marketing of the copra is the sole responsibility of a statutory marketing authority, the Copra Marketing Board. It would have been desirable to estimate the costs and benefits of marketing and processing separately, to assess economic efficiency and profitability at each stage. However, an attempt to collect specific data on these activities to make such estimates was not successful.

Two types of budgets were prepared for each smallholder farm model for the four tree crop products under study. First, a financial or market price model was prepared using market prices for all the inputs and outputs. The model budgets in market prices were decomposed into traded (exportables and importables) and non-traded items. Traded inputs are classified as FRCs. Second, the market price models were transformed into economic or shadow price models using the shadow prices and by removing all transfer payments (e.g. price support, bounties and levies[7]).

Inputs and outputs can be valued using constant or current prices. Under the constant price approach, the analyst assumes that inflation exerts the same effect on both costs and benefits. According to Gittinger (1982, p. 76), the constant price approach 'is simpler and involves less calculation than working in current prices', and is adopted in the present study.

The standard conversion factor (SCF) approach is used to value all benefits and costs in border prices whereby the values of domestic resources are converted into border prices using an SCF. It is considered the most relevant approach for developing countries to eliminate market distortions (Gittinger 1982; Ward et al. 1991).

The SER[8] is derived using the methods suggested by Gittinger (1982, p. 249) and Squire and van der Tak (1975, p. 93). This approach makes use of the theoretical relationship between the SCF and SER:

SER = OER / SCF.

When the SCF is used to estimate border prices of non-traded items, as adopted in this research, the SER can be derived through its relationship with SCF.

[7] Competitiveness and comparative advantage estimates exclude price support (a transfer payment) as those payments are not sources of either (although they might have increased private profitability with respect to a particular activity during the study period). Price support is not seen to be a policy measure that the government plans to use in tree crop industries in the future.
[8] Under the floating exchange rate regime, a market-determined OER is expected to align with the SER (that is, there is no difference between the two rates) if all other distortions in the economy are eliminated. Given the level of distortion in the domestic economy (protected by tariff rates of approximately 10 per cent), the OER and SER differ and they move together until the equilibrium rate is reached.

Discounted cash flow analysis was undertaken to account for the time value of money as the study period spans from 20 to 50 years, from planting to the end of the economic life of most of the crops. Following the World Bank (1985), ADB (1993b) and Kannapiran et al. (1993), a discount rate of 12 per cent per year is used to represent the opportunity cost of capital in PNG. Extending the economic life more than 20 years does not have much impact on the results of the analysis because of the effects of discounting. Moreover, forecasting benefits and costs beyond 20 years is not realistic.

Three types of sensitivity analyses are undertaken. The first test is of the sensitivity of the estimates of the DRC ratios to output prices which are varied by 30 per cent. Tree crop export income has been fluctuating by an annual average of 30 per cent, mainly due to fluctuations in world commodity prices but also to some extent to variability in quantity produced (Kannapiran 1997). Again, the break-even export and farm-gate prices of each commodity are estimated after the price changes.

Second, domestic inflation, measured by the consumer price index (CPI), increased by about 30 per cent (Kannapiran and Wosae 1995) after the devaluation, and might have increased the DRCs. The costs of supply of electricity, transport, telecommunications and banking services, and to some extent the prices of traditional staples, are therefore likely to have increased. Tree crop producers use a large quantity of imported components. A 30 per cent increase in the DRC is simulated as part of the sensitivity analyses, and the impact is measured to gauge the sensitivity of DRC ratios to the inflationary pressures of a devaluation.

Finally, the various criteria are measured with and without the effects of the devaluation. All other factors are kept constant, and the currency values of US$1.05/K (without devaluation) and US$0.55/K (with devaluation) are used in the factual and counterfactual analyses.

Data collection

Annual data on tree crop production and export were collected for the period from 1975 to 1995 to estimate the various criteria. Farm budgets were prepared for the economic life of the investment subject to a maximum of 20 years. Costs of production vary widely because of differences in physical, agronomic and geographical features and farming systems. Nevertheless, it was possible to develop fairly representative farm models for each crop. Prices of inputs and outputs were collected from the respective industry corporations, mainly from their publications.

Value data were collected in market prices. Some of the data on the costs of production of cocoa, coffee, copra and palm oil were provided by DAL, Cocoa Board, Cocoa and Coconut Research Institute, Coffee Industry Corporation and Oil Palm Industries Corporation. Specific publications of these organisations were used to supplement these data sources (e.g. Omuru 1996; ADS (PNG) 1996; Peter 1996; Overfield 1994). A field survey was also carried out to update existing data and collect missing data.

Secondary sources of data were used to estimate factor prices, the real and nominal rates of interest, exchange rate and wage rates (see Kannapiran (1999, Appendix 1) for details).

A random sampling method was used to collect field data for the farm models. The data collected include the area planted, yield data, input and output prices, resources used, and marketing and processing costs. Most farmers, especially smallholders, do not keep any records of income and expenditure. In most cases, therefore, the published works of the industry corporations served as the reference materials to compare with the primary data collected. For coffee, according to Overfield (1994), the average yield of arabica coffee is between 0.7 t/ha and 1.0 t/ha of green bean for smallholders. An average of yield of 0.87 t/ha is considered suitable for use in the present model.

For copra, the East Coast tall is the predominant variety of coconut in PNG. Yarbro and Noble (1989) reported an average yield of 700 kg/ha of dried copra on the basis of 7.7 kg per tree for a planting density of 94 trees per hectare. A one-hectare coconut farm would normally have around 175 trees per hectare. On reconciling the yield data at 7 kg per tree for 175 trees, a yield of 1.25 t/ha of dry copra was calculated for use in this study.

Omuru (1996) reported a dried bean cocoa yield of 270 kg/ha for smallholders. He based his estimate on an average yield per tree of 0.8 kg reported by Yarbro and Noble (1989). A total yield of 200 kg was estimated for an average plant density of 449 trees per hectare whereas they admitted that in most areas there are around 800 trees per hectare. Their survey represents farms of different types, especially in terms of the age of their trees. According to Yarbro and Noble, more than 50 per cent of trees in their sample had not yet reached a state of maturity. In the present model, a yield is assumed of 700 kg/ha for mature trees with a planting density of 800 trees per hectare.

Farm models for smallholder palm oil were developed based on the cost, price and yield data provided by the Oil Palm Industry Corporation for four project sites.

Field-level data and data from other primary sources (farmers, processors, marketers and industry corporations) were used to estimate the price spreads between the farm gate and point of export. The data on price spreads from the point of export to the farm gate, and various conversion factors to convert the farm products into finished products, were supplied by the respective industry corporations and DAL. Questionnaires were designed (see Kannapiran 1999, Appendix 1) and used to collect data on product prices from marketing agencies and industry corporations. It is very difficult to get a precise apportionment of processing and marketing costs between domestic and foreign resource costs. A 50:50 basis was applied as a reasonable approximation, and sensitivity analysis showed that altering this basis had only marginal effects on results. Wages, electricity and transport are predominantly DRCs whereas fuel, chemicals, tools, technical manpower and shipping costs are predominantly FRCs.

The inputs and outputs of tree crop activities were decomposed into tradeable (exportables and importables) and non-tradeable components. Data on conversion factors were collected from published works of the World Bank (1985), ADB (1994) and DAL (Kannapiran 1993; Kannapiran et al. 1993). A shadow wage rate of 60 per cent market wages and an SCF of 0.9 are used. Traded items are valued at their border (international) prices. Exported goods are valued at the point of export in f.o.b. prices. Imports are valued at import parity prices in c.i.f. terms.

Cost items classified as DRCs include wages, seedlings and planting costs, and land clearing. Those classified as FRCs are chemicals, equipment, tools and seeds in the case of oil palm production (as they were initially imported).

Presentation and Discussion of Results

Estimates of the criteria used to assess comparative advantage and competitiveness are presented in Tables 1 and 2 at the farm gate and point of export, respectively, for the post-devaluation and pre-devaluation periods. Estimates for the latter period are in parentheses. The exchange earning rates of each commodity are presented in Table 3. Break-even prices[9] are furnished in Table 4, again with pre-devaluation prices in parentheses. First, a brief comment is made about the consistency of the DRC ratio and BCR results. This is followed by a discussion of the estimates by tree crop. The estimated DRC ratios are used in the interpretation of the results.

The BCR and DRC ratio estimates are consistent with each other with respect to each 'advantage or disadvantage' decision, except in marginal cases where they differ trivially (see, for example, the BCR and DRC ratio for comparative advantage before devaluation for copra at the point of export). By definition, both methods must yield similar results for such decisions. When ranking activities, however, the results from the two methods need not be consistent. Masters and Winter-Nelson (1995) found differences in rankings between the methods, and concluded that the BCR method is superior to the DRC method when there is a heavy reliance on non-traded inputs. On the other hand, Greenaway et al. (1994) confirmed that the rankings from both methods were consistent based on their empirical analysis. Tables 1 and 2 show inconsistent rankings between the DRC ratio and the BCR in all but one of the eight base-level measures for pre- and post-devaluation, competitive and comparative advantage, and at the farm gate and point of export. The only consistent ranking between the DRC ratios and BCRs is for competitiveness at the point of export in the post-devaluation period.

Cocoa

For cocoa, the DRC ratios in the post-devaluation period are, respectively, 0.52 and 0.30 at the farm gate and 0.43 and 0.26 at the point of export (see Tables 1 and 2). These measures indicate comfortable comparative and competitive advantage for the production and export of cocoa. The greater advantage at the point of export than at the farm gate means that PNG has an even greater comparative advantage, and firms are even more competitive, beyond the farm gate than in production.

Competitiveness and comparative advantage improved in all cases as a result of the devaluation, as expected. Two results are particularly noteworthy. First, the devaluation helped restore the competitiveness of producers, given that the DRC ratio at the farm gate declined from a marginal level of 1.0 in the pre-devaluation period to 0.52 in the post-devaluation period.

[9] In the case of palm oil, the break-even price refers to the per tonne equivalent of palm oil using a conversion factor of 0.22 to derive the fresh fruit bunch (FFB) price.

Table 1

Comparative Advantage and Competitiveness at the Farm Gate

Details	Cocoa	Copra	Coffee	Palm oil
	Ratio	Ratio	Ratio	Ratio
1. Competitiveness – DRC ratio				
1.1 Base level	0.52 (1.00)	0.99 (1.89)	0.44 (0.84)	0.43 (0.83)
1.2 With 30 per cent increase in prices (yields)	0.38 (0.72)	0.73 (1.40)	0.33 (0.64)	0.30 (0.57)
1.3 With 30 per cent decrease in prices (yields)	0.68 (1.63)	1.54 (2.94)	0.65 (1.24)	0.78 (1.50)
2. Comparative advantage – DRC ratio				
2.1 Base level	0.30 (0.58)	0.55 (1.05)	0.28 (0.53)	0.23 (0.45)
2.2 With 30 per cent increase in prices (yields)	0.22 (0.42)	0.41 (0.77)	0.21 (0.41)	0.16 (0.31)
2.3 With 30 per cent decrease in prices (yields)	0.49 (0.93)	0.84 (1.61)	0.41 (0.78)	0.41 (0.78)
3. Competitiveness – FBCR				
3.1 Base level	1.83 (1.00)	1.01 (0.57)	2.31 (1.30)	1.61 (1.13)
3.2 With 30 per cent increase in prices (yields)	2.38 (1.40)	1.32 (0.75)	3.00 (1.69)	2.10 (1.47)
3.3 With 30 per cent decrease in prices (yields)	1.28 (0.76)	0.71 (0.40)	1.62 (0.91)	1.13 (0.79)
4. Comparative advantage – EBCR				
4.1 Base level	2.51 (1.57)	1.53 (0.98)	3.21 (1.85)	2.09 (1.55)
4.2 With 30 per cent increase in prices (yields)	3.26 (2.03)	1.99 (1.14)	4.18 (2.40)	2.72 (2.02)
4.3 With 30 per cent decrease in prices (yields)	1.76 (1.10)	1.07 (0.61)	2.25 (1.29)	1.47 (1.09)

Table 2

Comparative Advantage and Competitiveness at the Point of Export

Details	Cocoa	Copra	Coffee	Palm oil
	Ratio	Ratio	Ratio	Ratio
1. Competitiveness – DRC ratio				
1.1 Base level	0.43 (0.83)	0.91 (1.73)	0.26 (0.50)	0.27 (0.51)
1.2 With 30 per cent increase in prices (yields)	0.31 (0.60)	0.65 (1.24)	0.20 (0.37)	0.19 (0.36)
1.3 With 30 per cent decrease in prices (yields)	0.71 (1.36)	1.50 (2.86)	0.39 (0.74)	0.46 (0.88)
2. Comparative advantage – DRC ratio				
2.1 Base level	0.26 (0.50)	0.51 (0.98)	0.17 (0.33)	0.16 (0.31)
2.2 With 30 per cent increase in prices (yields)	0.21 (0.40)	0.37 (0.71)	0.13 (0.25)	0.12 (0.22)
2.3 With 30 per cent decrease in prices (yields)	0.47 (0.90)	0.83 (1.59)	0.25 (0.49)	0.27 (0.52)
3. Competitiveness – FBCR				
3.1 Base level	1.94 (1.27)	1.08 (0.64)	2.48 (1.50)	2.10 (1.54)
3.2 With 30 per cent increase in prices (yields)	2.53 (1.65)	1.40 (0.84)	3.23 (1.96)	2.73 (2.00)
3.3 With 30 per cent decrease in prices (yields)	1.36 (0.89)	0.75 (0.45)	1.74 (1.05)	1.47 (1.08)
4. Comparative advantage – EBCR				
4.1 Base level	2.50 (1.70)	1.51 (0.93)	3.18 (1.97)	2.49 (1.87)
4.2 With 30 per cent increase in prices (yields)	3.25 (2.20)	1.96 (1.21)	4.13 (2.56)	3.23 (2.44)
4.3 With 30 per cent decrease in prices (yields)	1.75 (1.19)	1.05 (0.65)	2.22 (1.38)	1.74 (1.31)

Table 3

Exchange Earning Rates of Commodities at the Farm Gate and Point of Export

Details	Cocoa	Copra	Coffee	Palm oil
	US$/K	US$/K	US$/K	US$/K
1. At the farm gate				
1.1 In market prices of DRC	1.05	0.55	1.25	1.26
1.2 In shadow prices of DRC	1.61	0.90	1.77	2.13
2. At the point of export				
2.1 In market prices of DRC	1.27	0.60	2.13	2.07
2.2 In shadow prices of DRC	1.89	1.04	2.85	3.36

Table 4

Break-Even Prices at the Farm Gate and Point of Export

Details	Cocoa	Copra	Coffee	Palm oil
	K/t	K/t	K/t	K/t
1. Break-even farm-gate price				
1.1 For competitive advantage	1139 (949)	359 (333)	920 (863)	129 (96)
1.2 For comparative advantage	800 (632)	222 (197)	620 (568)	95 (66)
2. Break-even export price				
2.1 For competitive advantage	1580 (1270)	449 (393)	1063 (919)	301 (215)
2.2 For comparative advantage	1226 (949)	320 (272)	778 (646)	239 (162)

Second, results of the sensitivity analyses show different effects of a 30 per cent decline in prices (yields) between periods. When prices (yields) decline by 30 per cent from the mean level in the pre-devaluation period, competitiveness is lost for the industry as a whole at both the farm and export levels. However, it is restored after the devaluation. This finding suggests some risk for the private sector in investing in cocoa on a large scale when world prices are depressed. However, the risks for private sector investment have been reduced by the devaluation. In general, the cocoa industry is efficient and devaluation improved not only industry profitability but also the capacity to absorb commodity price shocks.

The exchange earning rate[10] of cocoa exports is US$1.05 per K (US$1.61 per K) in market prices (shadow prices) at the farm gate during the pre- and post-devaluation periods (see Table 3). At the industry level, it is US$1.27 per K (US$1.89 per K) in market prices (shadow prices). The exchange earning rate is thus much higher than the official exchange rate throughout the study period.

The break-even farm-gate and export prices per tonne, respectively, for competitive advantage increased from K949 to K1139 and K1270 to K1580 (see Table 4). The equivalent prices per tonne for comparative advantage increased from K632 to K800 and K949 to K1226. The higher break-even prices after devaluation reflect the impact of increased costs of inputs. There were years during the pre-devaluation period when prices fell well below the break-even prices for competitiveness.

Copra

Competitiveness in copra production and export had been absent until recently; it was restored by the devaluation which led to reductions in the DRC ratio from 1.89 to 0.99 and from 1.73 to 0.91 at the farm gate and export levels, respectively.[11] Comparative advantage had also been marginal but, following devaluation, the DRC ratio improved from 1.05 to 0.55 at the farm gate and from 0.98 to 0.51 at the point of export (see Tables 1 and 2). This finding suggests that the devaluation was sufficient to make the copra industry marginally competitive and to restore a clear level of comparative advantage.

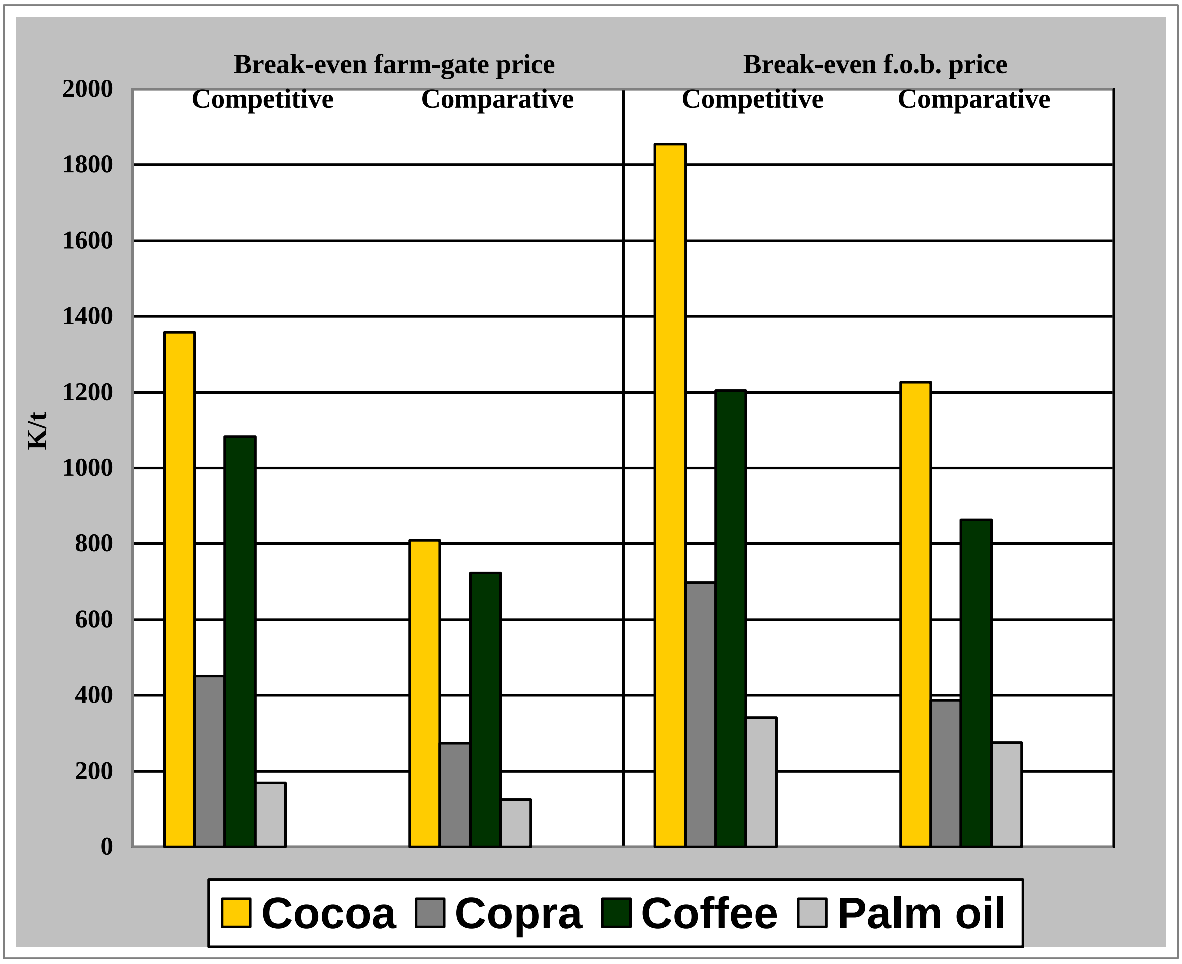
Sensitivity analyses suggest that when copra export prices (quantities) decline by 30 per cent from their mean levels, competitiveness deteriorates at both the farm gate and point of export. Also, comparative advantage is lost at both the farm gate and point of export during the pre-devaluation period (but not in the post-devaluation period).

The exchange earning rate of copra exports at market (shadow) prices is US$0.55 per K (US$0.90 per K) at the farm gate and US$0.60 per K (US$1.04 per K) at the point of export (see Table 3). These rates are the lowest among the export crops, and do not change much with the devaluation. The results suggest that copra exports are likely to cause downward pressure on the value of the Kina.

[10] The rates are the same before and after devaluation because the effects of devaluation are precisely offset in the estimate by changes to the denominator in equation 3, which is the exchange rate.

[11] World copra and coconut oil prices have risen sharply to historically high levels in 1999. However, it was decided to ignore this price rise when estimating the measures of competitiveness and comparative advantage of copra because it was felt that high prices would be unlikely to prevail in the long term. Commodity forecasters have made gloomy prognoses of price trends for these products.

Figure 1 Break-even farm-gate and export prices to reach competitiveness and comparative advantage for a 30 per cent increase in DRC



The break-even farm-gate and export prices per tonne are, respectively, K359 and K449 to reach competitiveness and K222 and K320 to achieve comparative advantage (see Table 4). The devaluation increased the break-even prices due to the increased costs of imported and domestic inputs used in copra production. During the pre- and post-devaluation periods, prices were often well below these break-even prices.

In the event of devaluation-linked inflation increasing DRCs by 30 per cent, the break-even farm-gate and export prices per tonne become K452 and K697 to reach competitiveness and K274 and K387 to attain comparative advantage (see Figure 1). During the pre- and post-devaluation periods, prices often went well below all these break-even prices.

Coffee

Coffee has the strongest competitiveness at the point of export, the second strongest competitiveness to palm oil at the farm gate, and second strongest comparative advantage to palm oil at both the farm gate and industry level (Tables

1 and 2). For competitiveness and comparative advantage, respectively, the DRC ratios are 0.44 and 0.28 at the farm gate and 0.26 and 0.17 at the point of export. Yet ADB (1993b) reported adverse DRC ratios for coffee in PNG. This was prior to the devaluation and the situation has changed sufficiently to make these estimates out-of-date. The strong increases in advantage at the point of export relative to the farm gate are probably due to the competitive nature of the industry that encourages efficient resource use and fosters profit sharing between the producers, marketers, processors and exporters (Temu 1995).

The industry as a whole remains competitive when the price or yield is reduced by 30 per cent, but competitiveness is lost at the farm gate without the devaluation, as indicated in the sensitivity analyses (see Tables 1 and 2). Competitiveness is emphatically restored at the farm gate after the devaluation, suggesting that the coffee smallholder industry is now strong enough to meet the challenge of commodity price variability without any stabilisation scheme or support from the government.

The exchange earning rate of coffee exports at the farm gate is US$1.25 per K (US$1.77 per K) in market prices (shadow prices). At the point of export, it is US$2.13 per K (US$2.85 per K) in market prices (shadow prices) (Table 3). Because the rate is much higher than the OER, there is advantage in the production and export of coffee. Coffee is the second most efficient converter of DRCs into foreign exchange and supports the Kina value at higher than the market rate.

The break-even farm gate and export prices per tonne are, respectively, K920 and K1063 to reach competitiveness and K620 and K778 to achieve comparative advantage. Coffee prices have been above break-even prices in the past 20 years. After the devaluation, the break-even farm-gate and export prices per tonne, respectively, increased from K863 to K920 and K919 to K1063 to reach competitiveness (see Table 4). The equivalent changes to reach comparative advantage were from K568 to K620 and K646 to K778. The higher break-even prices after devaluation suggest an increase in the prices of imported inputs and higher domestic prices.

With a devaluation-linked inflation increase of 30 per cent in DRCs, the break-even farm-gate and export prices become K1082/tonne and K1205/tonne to reach competitiveness, and K723/tonne and K864/tonne to attain comparative advantage (see Figure 1). During the pre-devaluation period, there are instances when farm-gate prices went below the break-even levels for competitiveness.

Palm oil

In terms of competitiveness and comparative advantage, the palm oil industry is stronger than the other three tree crop industries at the farm gate and second only to coffee in competitiveness at the point of export (Tables 1 and 2). The DRC ratios for competitiveness and comparative advantage, respectively, are 0.43 and 0.23 at the farm gate and 0.27 and 0.16 at the point of export. As for coffee, there is a strong increase in advantage at the point of export over the farm level, due to highly efficient processing operations but also perhaps to the disproportionate sharing of profit between producers and exporters in favour of the latter (Gumoi 1993). With devaluation, the competitiveness and comparative advantage in the production and export of palm oil improved at the farm gate and at the point of export.

Sensitivity analyses show that the industry is strong enough at both the farm and industry levels to meet the challenges of likely commodity price and yield variations after devaluation of the Kina (see Tables 1 and 2). A price (yield) decline by 30 per cent from the mean level does not affect either competitiveness or comparative advantage, except for competitiveness at the farm level in the pre-devaluation period, as for other crops. This finding suggests that the oil palm industry possesses the potential for further expansion if suitable land can be found.

The exchange earning rate of palm oil exports at the farm level is US$1.26 per K (US$2.13 per K) at market (shadow) prices. At the export level, it is US$2.07 per K (US$3.36 per K) at market (shadow) prices (Table 3). The rate is hence much higher than the official exchange rate and the production and export of palm oil improves the value of the Kina.

The break-even farm-gate and export prices per tonne are, respectively, K129 and K301 to reach competitiveness and K95 and K239 to achieve comparative advantage. They increased by about 20 per cent after devaluation (see Table 4). The higher break-even prices with devaluation are again due to increases in the prices of imported inputs.

In the event of devaluation-linked domestic inflation that increases DRCs by 30 per cent, the break-even farm-gate and export prices per tonne to reach competitiveness increase to K169 and K341, respectively. The equivalent figures to attain comparative advantage are K125 and K275 (see Figure 1). During the pre- and post-devaluation periods, there is no instance when prices went below any of these break-even prices. While the devaluation improved profitability and the capacity to manage commodity price shocks, it was insufficient to avoid all risk of loss.

Policy Analysis Matrix

A policy analysis matrix (PAM) is an effective tool to measure the impact of government policy on the private and social profitability of economic activities. The format of a PAM is illustrated in Table 5. According to Monke and Pearson (1989), it is suitable for agricultural price policy analysis and for evaluating public investment policy and efficiency. The PAM analysis provides an insight into the adverse impacts of policies pursued. Detailed discussion on the application of a PAM is available in Monke and Pearson (1989) and ADB (1993b).

Discounted values of outputs and inputs in the PAM were estimated from farm models and are reported in domestic currency in Table 6. The price of traded output is exclusive of price support and stabilisation effects (as those transfer payments are not sources of economic efficiency). Table 6 reveals that private profitability is always lower than social profitability in production and for the whole industry. This is due to the distortionary effects on prices of policies.

Table 5

Policy Analysis Matrix Format

Details	Outputs	Tradeable inputs (FRCs)	Non-tradeable inputs (DRCs)	Profits
Private (market prices)	A	B	C	D
Social (shadow prices)	E	F	G	H
Policy effects	I	J	K	L

Sources: Monke and Pearson (1989); ADB (1993b).

Notes:

Private Profits	D = A – B – C	Social profits	H = E – F– G
Output Transfers	I = A – E	Input transfers	J = B – F
Factor Transfers	K = C – G	Net Transfers	L = D – H
Market Price	DRC = C/(A – B)	Shadow Price	DRC = G/(E – F)

Nominal protection coefficient = A/E

The magnitudes of policy effects vary from negligible to substantial. Three points are worth noting. First, the policy effects on profitability between levels are much higher at the point of export for cocoa and coffee, are significantly lower at the point of export for palm oil, and are about the same at both the point of export and farm gate for copra (see Table 6). Overall, the effects on profitability are high at the point of export for cocoa and copra, moderate for coffee and low for palm oil. At the farm gate, they are high for copra and moderate for the other three crops. Second, the policy effects on tradeable inputs are low for all crops except copra at the farm gate where they are moderate. Finally, the policy effects on non-tradeable inputs are generally high. Distortions in the prices of tradeables are much less than those in non-tradeables because of the effects of tariffs. Invariably, therefore, the policy impacts are greater on domestic resources (non-tradeables).

Table 6

Policy Analysis Matrix for Four Major Tree Crops at the Farm Gate and Point of Export

Details	Tradeables		Domestic factors	Profits
	Outputs	Inputs		
Cocoa – Farm Gate	(K000)	(K000)	(K000)	(K000)
Private	760	132	244	384
Social	760	120	162	478
Policy effects	0	12	82	-94
Cocoa – Point of Export				
Private	980	327	522	131
Social	980	296	354	330
Policy effects	0	31	168	-199
Copra – Farm Gate				
Private	92	17	70	5
Social	92	13	43	36
Policy effects	0	4	27	-31
Copra – Point of Export				
Private	110	26	76	8
Social	110	24	50	36
Policy effects	0	2	26	-28
Coffee – Farm Gate				
Private	643	40	265	338
Social	643	36	188	419
Policy effects	0	4	77	-81
Coffee – Point of Export				
Private	1071	162	573	336
Social	1071	146	415	510
Policy effects	0	16	158	-174
Palm Oil – Farm Gate				
Private	53	17	15	21
Social	53	15	10	28
Policy effects	0	2	5	-7
Palm Oil – Point of Export				
Private	160	46	30	84
Social	160	41	21	98
Policy effects	0	5	9	-14

Policy Issues

Results show that coffee, cocoa and palm oil are internationally competitive and have a comparative advantage at all levels while the copra industry has comparative advantage throughout the study period but only gained competitiveness after the devaluation. Sensitivity analyses show that, without devaluation, competitiveness is lost at the farm level for all commodities when the commodity prices decline by 30 per cent. Competitiveness is restored after devaluation in the cases of cocoa, coffee and palm oil. Coffee and palm oil are more efficient in earning foreign exchange than the other two commodities. The devaluation has improved competitiveness and comparative advantage at all levels for all commodities. Some policy implications follow.

The DRC ratios of the copra export industry are the lowest among the tree crops, and the devaluation was just sufficient to make producers in the copra industry competitive. Yet more than 75 per cent of producers are semi-subsistence smallholders who continue to produce a variety of coconut products. Despite the gloomy results suggesting doubtful financial viability of copra production for export, there are four reasons for the government to continue to support the smallholder industry. First, smallholders with coconut plantations have few alternative cash-earning activities, which suggests that the shadow price of their labour may be much lower than the rate used in this study. Second, there are strong cultural values attached to coconut cultivation. Third, coconut is one of the important components of food and a source of other village products for the semi-subsistence smallholder. It is difficult to calculate values of all products that are derived from coconut palms and, in this study, the focus has been solely on those products such as copra that are sold commercially. Hence, if the true shadow prices for inputs and all outputs were calculated, the crop could remain financially attractive to smallholders. Finally, recent high world copra and coconut oil prices, alluded to above, might well mean that the gloomy market forecasts for these products used in the current study are overstated.

There is sufficient evidence to conclude that all four tree crop industries are financially and economically viable under current conditions. They deserve continued assistance from the government if that assistance improves social welfare. Given the dynamic environment in which these industries exist, however, their long-run comparative advantage and competitiveness are not assured. Policy measures, at both the macroeconomic and microeconomic levels, are likely to be needed to help them maintain these advantages.

International competitiveness depends heavily on the stability of the macroeconomic environment (Han 1991). Macroeconomic policies relating to interest rates, price stability, equilibrium exchange rates and fiscal measures are generally regarded as essential macroeconomic conditions for strong international competitiveness. Other factors such as political stability (including industrial relations) also affect the competitiveness of an industry in the international market. It is therefore important that the government pursue an appropriate and consistent set of macroeconomic policies. Continuing efforts at economic reform, including the structural adjustment program, aim to make the economy more competitive and should benefit the tree crop industries in the long run.

More direct factors affecting international competitiveness are microeconomic in character. International competitiveness is determined not only by the costs of production but also by strategic decisions made by individual firms and the quality of their management of the product, its distribution and promotion. These factors are determined at the level of the individual firm where management decisions are made and production processes take place. In this study, it has been assumed that all firms make equally good management decisions in these areas so that price alone determines competitiveness. This is unlikely to hold in practice, and it should be kept in mind that not all firms involved in the production, processing and marketing of each tree crop are likely to be competitive or remain so in the future. Also, their competitiveness can be expected to alter over time.

Price competitiveness is likely to remain the most important dimension of competitive advantage for all crops in the foreseeable future, especially for palm oil and copra which will continue to be quite homogeneous export products for smallholders. On the other hand, increased scope can be expected for individual firms to introduce product differentiation, market focus and other non-price strategies in the coffee and cocoa industries. There are implications here for measuring competitiveness. As competitiveness among producers of an exported product differs more, so the basis of measuring competitiveness along the lines followed here becomes less tenable.

Long-term competitiveness depends heavily on enhanced productivity through technical change and increased technical efficiency. While most productivity gains are likely to result from improved technologies, scope also exists for improving the managerial skills of producers. Variations in levels of technical efficiency among smallholders (Gimbol, Battese and Fleming 1995; Overfield and Fleming 1998) reflect what could be achieved with proper management. Sustained productivity gains are the key to meeting the challenges of commodity price variability and any decline in the terms of trade in the tree crops sub-sector.

Diversification is another important aspect of tree crops policy. Most subsistence producers of tree crop exports have already diversified their activities and earn about 50 per cent of their income from food and livestock (Overfield 1994). Further diversification can help sustain competitiveness and comparative advantage in smallholder farming systems. Industry corporations and other key players in the tree crop industries can play a leading role to facilitate profitable diversification. This role would be more effectively implemented with better knowledge of the competitiveness and comparative advantage of whole tree-based farming systems, as opposed to specific knowledge of particular activities provided here.

Any interventions by the government in the form of price support or maintaining a level of budget support without an appropriate cost recovery plan in the tree crops sub-sector (which may be with good intention or under pressure from powerful group interests) are dubious. These policies, as indicated in various reports (for example, World Bank 1995; ADB 1993b), encourage inefficiency and prevent the industries from facing and surmounting challenges from international competition.

The coffee and palm oil industries each get about K10 million as budget support (above cost recovery) towards research and development, a form of hidden subsidy. Given the strong competitive advantage in each industry, it is advisable to impose a research and development levy to recover these costs when the industries are capable of generating adequate income. Industry corporations should become financially independent and self-financing, and any budgetary support by the government tied to a properly designed cost recovery plan. In the long term, the overall competitiveness of tree crop industries will be adversely affected by more rent-seeking activities in the absence of cost recovery.

Differences between comparative advantage and competitiveness reflected in the PAM highlight key areas for further policy direction. They reveal the need for economic reform to liberalise the economy further and to remove distortions caused by protectionist trade policies. Currently, distortions are still quite significant in PNG and competitiveness measures, in particular, are likely to be substantially improved by further macroeconomic reforms.

Frequent observations are made about inadequate economic infrastructure and inefficient support services being major obstacles to the development of tree crop industries in that some of the advantage in production would be dissipated by less efficient services provided by the non-traded sector in processing and marketing. Invariably, reports of various studies and missions point out this issue (for example, ADB 1993a). These observations are not borne out in this study in that the measures of comparative advantage and competitiveness are greater at the point of export than at the farm gate for all crops. PNG has an even greater comparative advantage, and is even more competitive, in each of the four industries as a whole than in production alone. However, two caveats should be made here before any recommendation is made that infrastructure and support services are adequate. First, this result is based on average budgets for production, processing and marketing; inadequate infrastructure and support services are still likely to be a major constraint to many producers. Second, no study has been made of the split between profit and costs in marketing margins. One explanation for the above finding could be that processors and exporters are able to capture a larger share of the profit than producers. The relationship between the farm-gate and export prices needs to be evaluated to explain why comparative advantage and competitiveness are lower at the farm level than the export level, particularly in the oil palm industry.

References

ADB (1993a), *Country Operational Strategy Study for Papua New Guinea*, Asian Development Bank, Manila.

ADB (1993b), *Industrial Crops in Asia*, Staff Paper No. 7, Agriculture Department, Asian Development Bank, Manila.

ADB (1994), *Project Performance Audit Report: Cape Rodney Smallholder Development Project in Papua New Guinea*, No. L-656-PNG(SF), Asian Development Bank, Manila.

ADS (PNG) (1996), Review of oil palm fresh fruit bunch pricing formula, A consultancy report financed by the World Bank and prepared for the Commodity Working Group, Government of PNG, Port Moresby.

Ali, I. (1986), *Rice in Indonesia: Price Policy and Comparative Advantage*, Staff Paper No. 29, Asian Development Bank, Manila.

Alpine, R.W.L. and Pickett, J. (1993), *Agriculture, Liberalisation and Economic Growth in Ghana and Cote d'Ivoire, 1960-1990*, OECD Development Centre, Paris.

Appleyard, D. (1987), *Comparative Advantage of the Agricultural Production System and its Policy Implications in Pakistan*, Economic and Social Development Paper 68, Food and Agriculture Organization of the United Nations, Rome.

Balassa, B. (1965), 'Trade liberalisation and revealed comparative advantage', *Manchester School of Economic and Social Studies* 33, 99-124.

Balassa, B. (1977), 'A stage approach to comparative advantage in economic growth and resources', in I. Adelman (ed.), *Proceedings of the Fifth Congress of the International Economic Association 1977, Tokyo, Japan*, Vol. 4, Macmillan, London, pp. 121-156.

Balassa, B. (1978), 'Exports and economic growth: further evidence', *Journal of Development Economics* 5(2), 181-189.

Balassa, B. (1981), 'Shifting pattern of world trade and competition', in *Growth and Entrepreneurship: Opportunities and Challenges in a Changing World*, International Chamber of Commerce, Paris, pp. 9-23.

Bruno, M. (1967), *The Optimal Selection of Export Promoting and Import Substituting Projects, Planning the External Sector: Techniques, Problems and Policies*, Report on the First Interregional Seminar on Development Planning, Ankara, Turkey, United Nations, New York, pp. 88-135.

DAL (1995), *White Paper on Agriculture*, Department of Agriculture and Livestock, Konedobu.

Deardorff, A.V. (1984), Comparative advantage and international trade and investment in services, Paper presented at the Third Annual Workshop on US-Canadian Relations, October.

Department of Finance (1997), *1998 Supply Bills and Revenue Reforms*, Waigani.

Gimbol, K.C., Battese, G.E. and Fleming, E.M. (1995), 'Technical efficiencies of smallholder cocoa producers in Papua New Guinea: a stochastic frontier analysis', *Quarterly Journal of International Agriculture* 34(4), 337-357.

Gittinger, J.P. (1982), *Economic Analysis of Agricultural Projects*, 2nd edn, Johns Hopkins University Press, Baltimore.

Gonzales, L.A. (1984), *Philippines Agricultural Diversification: A Regional Economic Comparative Advantage Analysis,* Final report submitted to ADB as a component of a report on the assessment of food demand-supply prospects and related strategies for developing member countries of ADB, International Food Policy Research Institute, Washington, D.C.

Gonzales, L.A., Kasryno, F., Perez, N.D. and Rosegrant, M.W. (1993), *Economic Incentives and Comparative Advantage in Indonesian Food Crop Production,* Research Report No. 93, International Food Policy Research Institute, Washington, D.C.

Goodman, B. and Ceyhun, R. (1976), ‘U.S. export performance in manufacturing industries: an empirical investigation’, *Weltwirtschaftliches Archiv (Review of World Economics)* 112(3), 525-555.

Greenaway, D., Hassan, R. and Reed, G.V. (1994), ‘An empirical analysis of comparative advantage in Egyptian agriculture’, *Applied Economics* 26, 649-657.

Gumoi, M. (1993), *An Evaluation of The Effectiveness and Relevance of the Commodity Price Stabilisation Schemes in Papua New Guinea*, NRI Discussion Paper No. 74, National Research Institute of PNG, Waigani.

Han, S.S. (1991), ‘Public sector/private sector interface’, in *International Competitiveness: Interaction of the Public and the Private Sectors*, EDI Seminar Series, World Bank, Washington, D.C.

Haque, I. ul (1991), *International Competitiveness: Public Sector/Private Sector Interface¾Report on the Seminar in International Competitiveness: Interaction of the Public and the Private Sectors*, Economic Development Institute, World Bank, Washington, D.C.

Helpman, E. and Krugman, P. (1985), *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition, and the International Economy*, MIT Press, Cambridge, Mass.

Hufbauer, G.C. (1970), ‘The impact of national characteristics and technology on the commodity composition of trade in manufactured goods’, in R. Vernon (ed.), *The Technology Factor in International Trade*, National Bureau of Economic Research, Columbia University Press, New York.

Jabara, C.L. and Thomson, R.L. (1980), ‘Agricultural comparative advantage under international price uncertainty: the case of Senegal’, *American Journal of Agricultural Economics* 62(2), 188-198.

Jarrett, F.G. and Anderson, K. (1989), *Growth, Structural Change and Economic Policy in Papua New Guinea: Implications for Agriculture*, Pacific Policy Paper No. 5, Australian National University, Canberra.

Kannapiran, C. (1993), *Food Security: Rice Production Policy in Papua New Guinea*, Policy Discussion Paper, Department of Agriculture and Livestock, Konedobu.

Kannapiran, C. (1997), Macroeconomic impacts of export instability: a case of tree crop exports in Papua New Guinea, Paper presented at the 41st Annual Conference of the Australian Agricultural and Resource Economics Society, Gold Coast, January.

Kannapiran, C., Togiba, C., Taporaie, A. and Kendica, J. (1993), *Staff Appraisal Report PNG¾Central Province Smallholder Rubber Development Project*, Department of Agriculture and Livestock, Konedobu.

Kannapiran, C. and Wosae, C. (1995), ‘Floating exchange rate and sinking kina value’, *Current Issues (National Research Institute of PNG)* 3(2), 28-31.

Kannapiran, C.A. (1999), Analyses of Economic Efficiency and Macroeconomic Impacts of Export Fluctuations and Price Policy in the Tree Crops Industries in Papua New Guinea, PhD thesis, University of New England, Armidale.

Krueger, A.O. (1966), ‘Some economic costs of exchange control: the Turkish case’, *Journal of Political Economy* 74, 466-480.

Krueger, A.O. (1978), ‘Effects of exports from new industrial countries on US industries’, in W. Kasper and T.G. Parry (eds), *Growth, Trade and Structural Change in an Open Australian Economy* Centre for Applied Economic Research, University of New South Wales, Sydney.

Leamer, E.E. (1984), *Sources of International Comparative Advantage*, MIT Press, Cambridge, Mass.

Leontief, W. (1966), *Input-Output Economics*, Oxford University Press.

Little, I.M.D. and Mirrlees, J.A. (1982), *Project Appraisal and Planning for Developing Countries*, Basic Books, New York.

Masters, W.A. and Winter-Nelson, A. (1995), ‘Measuring the comparative advantage of agricultural activities: domestic resource costs and the social cost-benefit ratio’, *American Journal of Agricultural Economics* 77(2), 243-250.

Monke, E.A. and Pearson, S.R. (1989), *The Policy Analysis Matrix for Agricultural Development*, Cornell University Press, Ithaca.

Morris, M.L. (1990), *Determining Comparative Advantage Through DRC Analysis: Guidelines Emerging from CIMMYT's Experience*, Economics Paper No. 1, CIMMYT, Mexico City.

Newbery, D.M.G. and Stiglitz, J.E. (1981), *The Theory of Commodity Price Stabilisation¾A Study in the Economics of Risk*, Oxford University Press, New York.

Ohlin, B. (1933), *Interregional and International Trade*, Harvard University Press, Cambridge, Mass.

Omuru, E.E. (1996), *Cocoa and Coconut Plantation Cost of Production Survey 1996*, Cocoa and Coconut Research Institute, Keravat.

Overfield, D. (1994), *Coffee and Smallholder Households: Economic Issues and Interim Results*, Coffee Discussion Paper No. 10, Coffee Industry Corporation, Goroka.

Overfield, D. and Fleming, E. (1998), The technical efficiency of smallholder coffee production in Papua New Guinea: implications for research and extension, Unpublished paper, Tree Crops Policy Options Project in Papua New Guinea, University of New England, Armidale.

Perkins, F. (1994), *Practical Cost Benefit Analysis: Basic Concepts and Applications*, Macmillan, Melbourne.

Peter, R. (1996), *Cocoa Market Report, July–September*, Economics Division, Cocoa Board of PNG, Madang.

Peter, R. (1997), ‘Food import substitution in Papua New Guinea: a case study of sugar production’, in E. Fleming and J.B. Hardaker (eds), *Strategic Issues in the Economic Development of Melanesian Agriculture*, National Centre for Development Studies, Canberra, pp. 50-74.

Porter, M.E. (1990), *The Competitive Advantage of Nations*, Free Press, New York.

Pragma Corporation (1991), *Comparative Advantage Study of Selected Industrial Crops in Asia*, Report to the Asian Development Bank, Manila.

Samuelson, P.A. (1949), 'International factor price equalization once again', *Economic Journal* 59, 181-197.

Scandizzo, P.L. and Bruce, C. (1980), *Methodologies for Measuring Agricultural Price Intervention Effects*, Staff Working Paper No. 394, World Bank, Washington, D.C.

Schuh, G.E. (1990), 'The new macroeconomics of food and agricultural policy', in C.K. Eicher and J.M. Staatz (eds), *Agricultural Development in the Third World*, 2nd edn, Johns Hopkins University Press, Baltimore.

Setae, M. (1994), 'Delivery of agricultural services in PNG: strategies and options towards the next decade', *Papua New Guinea Journal of Agriculture, Forestry and Fisheries* 37(1), 19-24.

Soderstrom, H.T. (1985), 'National experience of exchange rate and trade interaction', in T. Peeters, P. Praet and P. Reding (eds), *International Trade and Exchange Rates in the Late Eighties*, North-Holland, Amsterdam.

Squire, L. and van der Tak, H.G. (1975), *Economic Analysis of Projects*, Johns Hopkins University Press, Baltimore.

Steinherr, A. (1985), 'Competitiveness and exchange rates', in T. Peeters, P. Praet and P. Reding (eds), *International Trade and Exchange Rates in the Late Eighties*, North-Holland, Amsterdam.

Temu, I. (1995), *Price Policy Analysis: The Case of Coffee in Papua New Guinea*, NRI Discussion Paper No. 79, National Research Institute, Waigani.

Thomas, H.C. (1988), *A Study of Trade among Developing Countries, 1950-1980: An Appraisal of the Emerging Pattern*, North-Holland, Amsterdam.

Todaro, M.P. (1989), *Economic Development in the Third World*, 4th edn, Longman, London.

Tucker, K. and Sundberg M. (1986), *Comparative Advantage and Service Intensity in Traded Goods*, ASEAN-Australia Economic Paper No. 23, Australian National University, Canberra.

Vincent, D., Weisman, E., Pearce, D. and Quirke, D. (1991), *An Economy-Wide Model of Papua New Guinea¾Theory, Data and Implementation*, Islands/Australia Working Paper No. 91/7, National Centre for Development Studies, Canberra.

Ward, W.A., Deren, B.J. and D'Silva, E.H. (1991), *The Economics of Project Analysis¾A Practitioner's Guide*, Economic Development Institute, World Bank, Washington, D.C.

Warr, P.G. (1992), *Comparative and Competitive Advantage in Manufactured Exports*, EDI Working Papers, Economic Development Institute, World Bank, Washington, D.C.

Warr, P.G. (1994), ‘Comparative and competitive advantage’, *Asia-Pacific Economic Literature* 8(2), 1-14.

Woldekidan, B. (1994), *Short-Term Economic Consequences of Devaluing the Kina: A General Equilibrium Analysis for Papua New Guinea*, Special Publication No. 19, National Research Institute of PNG, Waigani.

World Bank (1985), *Papua New Guinea: Third Agricutural Credit Project*, Staff Appraisal Report No. 5635-PNG, Washington, D.C.

World Bank (1991), *Zimbabwe Agricultural Sector Memorandum*, Report No. 9429-ZIM, Washington, D.C.

World Bank (1992), *Papua New Guinea: Competitiveness, Growth and Structural Adjustment*, Report No. 10319-PNG, Washington, D.C.

World Bank (1994), *Papua New Guinea: Restructuring for Broad-Based Development Opportunities and Challenges*, Report No. 12982-PNG, Washington, D.C.

World Bank (1995), *Economic Recovery Program (ERP) Loan Document 1995: The Independent State of PNG*, Washington, D.C.

World Bank (1997), *Papua New Guinea: Accelerating Agricultural Growth¾An Action Plan*, Report No.16737-PNG, Washington, D.C.

Yarbro, S. and Noble, S. (1989), *Designing Monitoring Systems for Smallholder Agriculture in Papua New Guinea*, Working Paper No. 10, Australian Centre for International Agricultural Research, Canberra.

Yeats, A.J. (1989), *Shifting Patterns of Comparative Advantage: Manufactured Exports of Developing Countries*, Working Papers, International Economics Department, World Bank, Washington, D.C.

Zeitsch, J., Fallon, J. and Welsh, A. (1993), ‘Estimating the benefits from certain structural reforms in the Papua New Guinea economy’, in J. Millett (ed.), *Seminar on Employment, Agriculture and Industrialisation (Papers and Proceedings) 14-15 July 1993*, Institute of National Affairs, Port Moresby, pp. 248-266.