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Graduate School of Agricultural and Resource Economics
&
School of Economics

Export Performance in Papua New Guinea, 1960 to 1999

by

Euan Fleming and Anita Blowes

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Euan Fleming and Anita Blowes∗∗

Abstract

Stochastic dominance analysis was used to assess export performance in Papua New Guinea from 1960 to 1999. A country with abundant natural resources, Papua New Guinea was able to experience significant growth in total export values throughout the final four decades of the 20th century, with each succeeding decade stochastically dominating the previous one. The expansion of mineral and energy exports from the early 1970s was the major source of this growth.

The powerful influence of an expanding minerals and energy sector must nevertheless be of concern in that this sector and other non-agricultural resource sectors comprise mainly extractive or quasi-extractive industries given the production practices that currently exist. Little progress has been made in diversifying into secondary and tertiary exports. Furthermore, prospects for the mineral and energy sectors do not look bright, with a collapse of exploration and development in the mining industry (Duncan 2001:11).

Growth also took place in agricultural export values during the study period. However, it was more modest than the growth in resource-based non-agricultural exports and confined mainly to the 1960s and 1970s.

Key words: export performance; Papua New Guinea; stochastic dominance.

∗∗ Euan Fleming is an Associate Professor in the School of Economics and in the Graduate School of Agricultural and Resource Economics at the University of New England. Anita Blowes is an Honours Graduate of the School of Economics at the University of New England.
Contact information: School of Economics, University of New England, Armidale, NSW 2351, Australia. Email: efleming@pobox.une.edu.au.

1. Overview of Analysis

The question that we attempt to answer in this study is whether a developing South Pacific island country well endowed with natural resources was successful in improving commodity export performance over the final four decades of the twentieth century. Commodity export performance is analysed for Papua New Guinea from 1960 to 1999.

Stochastic dominance analysis was used to assess export performance across the four decades, which allowed a simultaneous assessment using two key criteria: the mean value of commodity exports and variability around the mean. Two analytical procedures were followed in its application. First, cumulative distribution functions were calculated and graphed for comparison between decades. This approach was useful where first-degree stochastic dominance or clear second-degree stochastic dominance prevailed. Second, the more advanced analytical procedure of stochastic dominance with respect to a function (Hardaker, Huirne and Anderson 1997, pp. 149-150) was used where stochastic dominance was not clear from a pictorial presentation.

The RISKROOT program devised by McCarl (1996a, 1996b) suited this purpose. RISKROOT was applied to two sets of data: the raw export values and trend-corrected export values within each decade. The latter approach assumes that participants in the export sector are only averse to variability around the trend in values whereas the former approach assumes they are averse to all variability. Results are reported for the approach using the raw export values, as the sets of results differ only in the extent of dominance.

Measures of absolute risk aversion were estimated assuming participants in the export sector have a normal relative risk-aversion coefficient of unity. This coefficient was divided by an estimate of the wealth of the participants to derive the absolute risk aversion coefficient that could then be compared with the break-even risk aversion coefficient (BRAC) estimated in the RISKROOT program. Because the risk-aversion coefficients are estimated by a crude approximation, we decided to adopt a conservative approach and include a buffer zone 100 per cent each side of the estimates of the coefficients. If the BRAC were to fall within this zone, the values were considered too close to each other to make an informed assessment of which decade is superior in export performance. No estimate fell within this buffer zone.

It would have been useful to take the further step of decomposing export values into their price and quantity components. Unfortunately, while such decomposition would have been possible for some exports, it is not for a considerable proportion of export commodities for the full study period.

The data used are values of total domestic commodity exports, and disaggregated values of agricultural and non-agricultural exports. All series were converted into US dollars using the pertinent annual average exchange rate. The series are expressed in real terms in 1999 prices, using the world export unit value index published by the International Monetary Fund (IMF) (2002) as a deflator.

Deficiencies in the available data restricted the analysis in two ways. First, agricultural exports are taken to include raw and processed agricultural products because it proved impossible to separate the value added by processors from that by agricultural producers of the raw material outputs. Second, gross export values were used instead of net value added. The latter series would have given a better picture of changes in export profitability but could not be used because cost data were almost universally unavailable.

Data were confined to annual observations because more time-disaggregated data were not available for the full study period. Quarterly data were available from 1970, and analyses undertaken on these data were helpful in confirming the results obtained using the annual data. Data published by BPNG (2000) and NCDS (1995) were supplemented with data from publications by NSO (1979) and DAL (1993).

Graphic representation of stochastic dominance between decades is presented while the RISKROOT outputs for stochastic dominance are also provided in summary form. As a supplementary measure, linear trends in values over the full study period are also reported for total, agricultural and non-agricultural exports. All export values are expressed in 1999 US dollars. Values taken from reference sources other than those published by national statistics departments and central banks that were published in nominal local currency terms are also converted to 1999 US dollars.

2.   Analysis of Commodity Export Performance

Trends in export values in Papua New Guinea over the whole study period are presented in Table 1. Results of the stochastic dominance analysis for total exports are presented in graphical form in Figure 1 and for RISKROOT analysis in Appendix 1. Comparable results for agricultural exports are presented in Figure 2 and Appendix 2 and for non-agricultural exports in Figure 3 and Appendix 3.

Table 1

Linear Trends in Total, Agricultural and Non-Agricultural Export Values in Papua New Guinea, 1960 to 1999

Trend coefficients in values (*t*-ratios) and annual percentage changes					
Total exports		Agricultural exports		Non-agricultural exports	
US$000	%	US$000	%	US$000	%
45 937.6 (14.23)	6.1	4513.0 (3.16)	1.8	41 424.6 (13.66)	9.6

2.1   Overall trend

Papua New Guinea experienced significant growth in non-agricultural export values throughout the study period and in agricultural exports in the 1960s and 1970s. Growth was clearly much greater for non-agricultural exports, at an average of US$41.4 million per annum compared with US$4.5 million per annum (and not sustained over the whole period) for agricultural exports. Even so, agricultural export values increased by an average of 1.8 per cent per annum for the study period as a whole. The expansion of mineral and energy exports from the early 1970s was the major source of overall export growth: total export values increased by US$45.9 million, or 6.1 per cent, per year. This growth was significant at less than 1 per cent significance level.

The 1970s stochastically dominated the 1960s strongly for the values of total exports as both agricultural and non-agricultural export values underwent large increases. The rate of expansion was much lower in the 1980s than in the 1970s, reflected by the presence of second-degree dominance, as the mean annual value of total exports increased by around 15 per cent with a much lower coefficient of variation. Increased values of non-agricultural exports were offset to some extent by a decline in

agricultural export performance, with export values in the 1980s slightly dominated by those in the 1970s.

Total export values in the 1990s stochastically dominated those in all previous decades. The effects of increased non-agricultural export values were much greater than a slight decline in agricultural export values to such an extent that a 60 per cent increase occurred in the mean annual value of total exports.

2.2   Agricultural exports

2.2.1   1960s and 1970s

The 1970s dominated the 1960s for the value of agricultural exports despite drought conditions in 1972 (McGregor and McGregor 1999:7) and the continuing constraining effects on agricultural exporters of the conservative policy of maintaining the domestic currency unit, the kina, at a high value against the currencies of trading partners. Expansion was largely supply-driven, with a rapid growth of tree crop output fuelled by projects to increase the planted tree crop areas of smallholders (Fleming and Yala 2001:25-39). Project success depended heavily on infrastructural development. Yala, Igitoi and Lummani (1999) attributed the growth of the oil palm industry, and concurrent expansion of copra and other export crops, in West New Britain Province to the building of road transport and port infrastructure. They also attributed the rapid expansion in coffee production to the construction of the highway in the Highlands that linked potentially rich farming areas to the port of Lae.

Expansion was not evenly spread among tree crop industries. The traditional commercial role of the coconut industry, producing both copra and coconut oil, as the principal source of agricultural and total exports prevailed in the 1960s. But coffee exports, which only commenced in the 1950s, had superseded exports of coconut products by the early 1970s and cocoa exports, which commenced before the second world war, achieved the same feat a few years later. Increases in smallholder incomes and exports in the coffee industry in the 1970s signalled one of the most outstanding successes in agriculture throughout the South Pacific. Smallholders in the Highlands followed the earlier example set by estates, and average annual coffee export earnings surged from US$43.5 million in the 1960s to US$152 million in the 1970s. At the end of the mid-decade world commodity boom, the coffee export value reached US$290 million in 1977, a figure not even to be approached in the following years of the study period.

Like coffee, cocoa was originally an estate crop but it increasingly became a smallholder crop to the extent that the proportion of output supplied by smallholders had increased from around one-quarter in 1970 to almost 60 per cent by the end of the decade (Fleming and Yala 2001:22). Export industry expansion was aided by

favourable physical conditions for cocoa production, prudent facilitatory and regulatory policies that encouraged the private processing and marketing of good-quality cocoa beans (Ivarami and Coulter 1992:108-9, Fleming 1996:65), and higher export prices in 1973-74 and 1977-79. Encouraged by an increase in prices in 1973 and 1974, the export volume increased from 22 kt in 1972 to 35.5 kt in 1974. The mean value of cocoa exports more than doubled from US$40.6 million in the 1960s to US$92.2 million in the 1970s while the coefficient of variation declined from 0.51 to 0.43. Cocoa exports eclipsed coffee exports in some years of the 1960s and again in 1974 when they achieved a global maximum value for the study period of US$111.4 million. But they lagged slightly behind coffee exports in mean value in the 1960s and well behind them in the 1970s.

The mean value of copra and coconut oil exports in the 1970s (US$81.8 million) was marginally lower than in the 1960s (US$84.8 million). Also, the coefficient of variation was much higher, at 0.40 compared with 0.16, as the consistent values of the 1960s gave way to greater variability in the 1970s in response to greater volatility in world oils prices. Values in the 1970s were generally lower, except for a period of high prices in 1973-74 (Fleming and Yala 2001:30) inducing a strong supply response that resulted in the highest volumes of both copra and coconut oil exports recorded to that time in the study period. The individual copra and coconut oil export values in this decade were the highest recorded over the whole study period.

The oil palm industry expanded through settlement schemes on a nucleus estate basis in the late 1960s and early 1970s following an appraisal by the World Bank in 1964 that found the crop to be well suited to certain areas (Christensen and Densley 1978). Substantial volume increases caused the value of exports to expand to US$24.7 million by 1979. The average value of exports in the 1970s was US$20.8 million. The rapid early growth of the industry augured well for what was to follow in the 1980s and 1990s.

Early experiments in tea production and processing led to the construction of a small factory in the Highlands in 1962, which resulted in the successful export of tea from 1964 (World Bank 1982). Although it was envisaged as an alternative cash crop to coffee for smallholders in the Highlands, tea remained predominantly an estate crop because tea production and post-harvest activities suited smallholders' skills, resources and circumstances less well than alternative crops such as coffee (Munnull 1973, World Bank 1982:236). High export prices in the late 1960s and early 1970s elicited a significant planting response and export supply continued to expand until 1977 when the tea export value approached US$20 million. The value then declined to US$13 million by the end of the 1970s. Overall, the 1970s averaged US$13.2 million compared with approximately US$1.4 million in the 1960s.

Rubber production was a mature industry by the beginning of the study period, with rubber having been a traditional export with a history preceding the second world war. On a simple decade-by-decade comparison, the exports of rubber declined substantially over the first two decades of the study period, from a mean value of US$11.8 million in the 1960s to US$7.8 million in the 1970s. The rate of decline was small during the 1960s, averaging US$0.13 million per annum, and steeper in the 1970s, averaging US$0.86 million per annum. The main factor behind this downward trend in output was the virtual halving of the area under rubber in the estate sector between the late 1960s and mid-1970s, resulting in a decline in export output from 6200 tonnes in 1970 to 4000 tonnes in 1979. This decline was caused primarily by uncertainty following political independence (Densley, Rady and Arnold 1978:2-5). The coefficient of variation increased markedly from 0.09 in the 1960s to 0.33 in the 1970s.

Three high-value non-traditional (HVNT) exports—pyrethrum, passionfruit juice and pulp, and groundnuts—flourished during the 1960s but declined during the 1970s. Pyrethrum was developed as a crop for smallholders in the early 1960s in areas of the Highlands that were considered too high in altitude for coffee (Anderson 1978). A foreign company, Busch Boake Allen Ltd, constructed a factory in 1964 to process the dried flowers (Anderson 1978), generating a profitable industry exporting crude pyrethrum extract. Export values peaked in 1968 at almost US$2 million, following the supply of 577 tonnes to the factory by smallholders in the previous year, their largest supply achieved but only a little more than one-half the quantity requested by the factory (Scoullar 1973:2). This peak marked the beginning of a rollercoaster ride for the industry that was to continue into the 1990s. Values declined steeply to under US$1 million by 1973 in which year Busch Boake Allen Ltd sold the factory to the government. Exports picked up a little in 1974 but then continued their decline throughout the remainder of the 1970s despite the initiation of a group production scheme in Enga province in 1975 (Fleming 1996:73). Scoullar (1973:29) had early recognised major problems of many unsuitable areas for planting resulting in low yields, inequitable distribution of cash returns that meant men got the lion's share while women and children did most of the work, and extension inadequacies.

Exports of passionfruit juice and pulp, which had begun in the mid-1950s, fetched between US$2 million and US$4 million throughout the 1960s. A slight increase in export values in the first three years of the 1970s was quickly reversed in 1973 and exports had ceased by the mid-1970s. The main reason for failure was lack of commercial viability in processing for export (Fleming 1996:74).

Although of less value than passionfruit juice and pulp exports, groundnut exports contributed up to US$1 million per year in export values in the 1960s from around 1500 hectares planted in the Markham Valley (Vance 1987:3). Their values had begun to decline towards the end of the decade but then picked up again in the early 1970s

before exports ceased altogether by 1977. Fintrac (1986) attributed industry failure to a lack of financial viability and inadequate processing facilities.

Cardamom and 'birds-eye' chillies possess the positive attributes of low maintenance requirements, an absence of pests and diseases, good growing conditions and a high value-weight ratio (Wyatt 1978). They achieved modest success as HVNT exports, beginning in the 1970s. Smallholder chilli production grew quite rapidly in the early 1970s in response to the opening up of export marketing possibilities. Export values peaked at around US$1 million in the late 1970s, a period of high world prices that induced a major outward shift in export supply. Cardamom exports began in 1974. Their boom period was to still to come.

2.2.2   1980s

In contrast to the period of expansion in the 1970s, agricultural export values in the 1980s were stochastically dominated by the values in the 1970s despite a substantial decline in the coefficient of variation. The 1970s dominated below the BRAC of 0.013 in Appendix 2 for an estimated risk-aversion coefficient of 0.0003. Tree crop export values were stagnant to declining (Fleming and Yala 2001:25-39), while there was a failure of new HVNT exports to emerge and existing ones to maintain export values. In the early 1980s, the government disadvantaged export-oriented agriculture by introducing tariffs of 10 per cent on goods produced by import-competing industries. The tariffs were increased mid-decade to 15 per cent (Economic Insights 1994:55).

Coffee exports had a mixed decade. On one hand, the value of coffee exports hit its second highest point of US$230.2 million during the world coffee boom of 1986, but this figure was still less than 80 per cent of the peak value in 1977. The boom was preceded by a period of low world prices in the early 1980s, lasting from 1981 until 1984, and low prices in the late 1980s (Fleming and Yala 2001:30). The value of exports had declined to US$121.6 million in 1988, a mere two years after their peak for the decade. Admittedly, the export value in 1988 was less than it could have been because the export volume was constrained to meet the requirements of the International Coffee Agreement (Siwatibau 1989:2). An outbreak of coffee leaf rust in 1986 threatened greatly to reduce export volumes and values in the second half of the decade but in the event had only a minor impact on output (Fleming and Antony 1993:103-104).

Cocoa exports declined appreciably in value from 1978, falling by over one-third to a mean value of US$60.7 million in the 1980s compared with 92.2 million in the 1970s. A substantial decline in the coefficient of variation only partly offset the decline in mean value. Export value fell from US$102.7 million in 1979 to US$56.3 million in 1983, recovered to US$86.9 million in 1984 before experiencing a precipitous decline

to only US$48.6 million by 1989. The decline from 1987 reflected the impact of lower world cocoa prices. Export volumes actually increased, from 37.0 kt in 1987 to 46.6 kt in 1989 (DAL 1993:17) because of the generous (and unsustainable) bounties paid from the cocoa stabilisation fund in the late 1980s (Fleming and Yala 2001:62-63). Concern was also growing about deteriorating cocoa quality caused by poor post-harvest methods and lack of appropriate grading standards. It led to the introduction of a major cocoa quality control and assurance project in the late 1980s in an attempt to raise the quality of cocoa beans (Ivarami and Yarbro 1992:172).

A mean export value of copra and coconut oil exports of US$51.5 million in the 1980s was just 63 per cent of the mean value in the 1970s. Furthermore, the coefficient of variation increased by 30 per cent to 0.52. Values were especially low in the early and late years of the decade, with the lowest value reached in 1986 at US$22.5 million. Such was the extent of the fall in world copra and coconut oil prices that the 1986 export value was only 20 per cent of the value two years earlier. Coconut oil exports made a higher contribution to the export of coconut products in the 1980s than they did in the preceding two decades.

Export values of palm oil continued to expand in the early 1980s, and peaked at US$89.2 million in 1984. The mean value for the decade was US$45.0 million, up US$24.2 million on the figure for the 1970s. High world prices in 1985 during the world oils market boom of 1984-85 meant that exports remained buoyant at US$72.5 million, before falling to US$32.7 million in 1986. In contrast to coffee and cocoa, world palm oil prices slumped earlier in the second half of the decade, more than halving between 1985 and 1986. Nevertheless, export volumes held up in the second half of the decade as more palms reached the age of maximum yielding capacity (Fleming 1999a:10-14). By 1989, export volume was 132 kt, higher than in 1986 when it was 129 kt (DAL 1993:17). The value of exports in 1989 was US$41.3 million, their highest level for five years but less than one-half their 1984 peak.

Tea exports continued the decline in value begun in 1978 to fall back to US$6.6 million by 1989, but the decline was interrupted by a brief revival in the middle of the decade. The 1989 value was one-half the value a decade earlier and one-quarter the mid-decade value. The export value initially declined from 1980 until 1982 before recovering in the global commodity boom of the mid-1980s to attain its highest recorded value of US$22.2 million in 1984, but it has been mostly downhill since. A world price decline from 1985 was the major factor contributing to this trend because export volumes remained fairly constant to 1990 (DAL 1993:17). The mid-decade revival meant that the mean value of US$11.1 million for the 1980s was not far below the mean value for the 1970s despite the secular decline in values.

The rubber industry declined further in the 1980s, with export values fluctuating between US$2.8 million and US$4.7 million during the decade. Values were well

below levels prevailing in the 1970s, with the mean annual value (US$3.8 million) virtually one-half the value in the 1970s. Estate output continued to fall with yet further decreases in planted area, which, at 10.6 kha in 1986, was less than one-third the area of 34.0 kha in 1970 (NCDS 1995). Smallholder rubber output went against the trend in the estate sector, increasing output share to around one-quarter of total rubber output (NCDS 1995). But intractable obstacles confronting the smallholder sector had already begun to emerge by the close of the 1970s that included low productivity, inadequate marketing services and extension advice, especially for more remote smallholders, and diseconomies of small scale in smallholder production (Fleming 1996:69).

A brief recovery occurred in the pyrethrum export industry in the early 1980s when an increase in world prices in the late 1970s temporarily lifted export values. The price effects were reinforced by a lagged increase in the volumes of exported extract. Decline set in again during the latter half of the 1980s. Fintrac (1986), Anderson (1978:3-12) and the World Bank 1982:238) cited numerous reasons for failure. They included inefficient and irregular roadside-buying services, security problems, relatively low returns to labour due to low farm-gate prices received relative to those of major East African competitors, insufficient rewards passed onto the women and children who did most of the work, unsuitable growing conditions in some areas, and chronic financial difficulties experienced by the processing plant resulting from high overhead costs in processing that in turn were caused by low factory utilisation rates.

The high export values for chillies in the late 1970s continued to encourage exports in the first two years of the 1980s, after which export values declined to negligible levels for the remainder of the decade as profits diminished with lower farm-gate prices. Cardamom exports experienced a typical boom-bust process in the 1980s (where niche exports achieve significant initial success followed by failure shortly thereafter). The boom was set in motion by a meteoric world price rise in the mid-1980s (prices more than doubled between 1982 and 1984) followed by an equally abrupt price fall from 1986 as new supplies flooded onto the world market from developing countries (Eyzaguirre 1996:113). Also, greater competition for labour emerged from coffee production with high world coffee prices in the mid-1980s. By the end of the decade, cardamom exports were US$0.4 million, compared with a peak of US$2.6 million in 1985, and were destined never to recover.

2.2.3   1990s

The result for the value of agricultural exports in the 1990s contrasted with that for total exports: the 1990s were clearly dominated by the 1980s as well as the 1970s. This outcome occurred despite large devaluations of the kina during the decade, beginning with a 10 per cent devaluation of the kina in January 1990 (King and

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Sugden 1997:23), which should have benefited export-oriented agriculture. Unfortunately, agricultural export industries were poorly placed to take advantage of the devaluation in the early years of the decade because of a calamitous decline in world prices of tree crop exports, and associated plummeting profitability in the tree crop industries. In fact, supported producer prices from 1990 to 1994 were frequently above f.o.b. export prices (Fleming 1999b:10-11).

Other exogenous factors that contributed to the stochastic dominance of the 1980s were the volcanic eruption followed by flooding and landslides in the major cocoa- and copra-producing area of the Gazelle Peninsula in 1994 (Fairbairn 1998:59, McGregor and McGregor 1999:6) and the widespread drought in the second half of 1997 and early 1998 (Yala and Levantis 1998). Law and order problems played their part in dampening the expansion of agricultural production and marketing (Yala and Levantis 1998:7), especially in the coffee industry in the Highlands (Fleming and Yala 2001:161-162). Increasing internal transport costs associated with deteriorating economic infrastructure (Shaw 1992:16) also contributed to the downward trend in agricultural export values. Finally, the government increased tariffs on goods produced by import-competing industries to 30 per cent in the early 1990s, which were accompanied by embargos and quotas on certain food imports (Economic Insights 1994:55).

The coffee industry led the way downwards as low coffee prices to 1993 adversely affected export performance. Export proceeds from coffee declined to a 25-year low of US$60 million in 1992 compared with US$151 million three years earlier. A mini revival in world prices led a recovery in export values to US$89 million in 1993. This revival was sustained by further increases in price such that coffee prices in US dollars increased more than threefold from 1993 to 1994 (Latukefu 1995:109). The value of coffee exports more than doubled to US$185.0 million in the four years to 1997, then increased to US$236.0 million in 1998 with a further smallholder supply response to favourable world prices and after shaking off any adverse effects of the drought and unusually severe frosts (Stapleton, Alu and Wheeler 1999:14). The export value was US$163.6 million at the end of the study period. The mean value for the decade was US127.0 million, down 13 per cent on the 1980s value, and the coefficient of variation was quite high at 0.44, as might be expected given the production and market instability experienced by the industry.

Cocoa exports began the decade at their lowest point for many years, valued at US$26.1 million, as the security problems worsened in traditionally the most important cocoa-producing province of North Solomons. The slide in values was arrested in the following year when exports were valued at US$30.1 million, but they fell back to a mere US$20.7 million in 1994 with volcanic eruptions in East New Britain that caused cocoa output to fall by 10 kt (McGregor and McGregor 1999:47). Thereafter, a recovery in world prices—the 1995 price was one-quarter higher than

the 1992 price (but still less than one-half the 1985 price) (Latukefu 1995:109)—and better production conditions saw export values recover to US$41.6 million in 1997 and maintain that level for the remainder of the period. A further recovery in world prices in 1997 and 1998 offset a decline in export volume in those years caused by the adverse effects of the 1997 drought on production in the major cocoa-producing areas of the Gazelle Peninsula, Madang and Karkar island (Manning 1997:5), especially in 1998 when the export volume of 26.1 kt was only 64 per cent of the 1996 volume. Exports did pick up in the final two years of the study period with a recovery from drought conditions and more output from North Solomons Province following the settlement of the Bougainville conflict. The 1999 export value was US$33.2 million, almost one-quarter higher than the value at the beginning of the decade. Despite this recovery, the cocoa industry had undoubtedly surrendered to palm oil its position as the second most valuable agricultural export after coffee in the final decade of the study period, as the mean annual value of exports almost halved to US$31.6 million.

Coffee still retained its position as the leading agricultural export earner by 23 per cent by the end of the 1990s, but in the third quarter of 2000 the crop was to experience the same fate that had earlier befallen cocoa, being overtaken by exports of palm oil. The export value of palm oil showed a steady increase in real terms in the early part of the decade, despite continued depressed world palm oil prices, reaching US$69.9 million in 1993 after commencing the decade at US$28.5 million. The world commodity boom caused an increase in the prices of oils in the mid-1990s and the 1994 average annual US dollar price of palm oil was 70 per cent higher than the 1990 price (Latukefu 1995:109). Combined with devaluation of the kina, this brought about a more than doubling of domestic prices between 1994 and 1996, with another increase in 1997 following further devaluation of the kina. By 1997, the export value of palm oil had reached US$117.7 million. The dark days of the early 1990s were well behind the industry that, like coffee and cocoa, has proved most successful in both agricultural production and adding value to raw agricultural output. The mean annual export value for the decade was US$82.6 million, almost double the mean value in the 1980s.

The mean export value of copra and coconut oil exports continued to decline significantly in the 1990s, down to US$38.2 million compared with US$51.5 million in the 1980s and less than one-half the mean value of US$81.8 million in the 1970s. As in the 1980s, values were particularly low in the early part of the decade, and it was not until 1996 that they started to pick up. There was a further setback in 1998 when the consequences of the 1997 drought and a cyclone were felt (Manning 1997:6). Copra export volume almost halved although coconut oil export volume changed little. There was some joy: the highest value for the decade was achieved in the final year, at US$63.7 million more than four times the 1991 value. Coconut oil exports contributed 58 per cent of the total coconut product exports for the decade.

Tea export values continued downwards in the first half of the 1990s, extending an uninterrupted trend from 1984. By 1994, exports were valued at US$3 million. Another mid-decade recovery in export prices, instigated to a large degree by developing a niche export market in Europe (Yala and Levantis 1998:7-9), saw exports recover quite sharply to US$7.4 million in 1996, and the value reached US$9.4 in 1998 with export volume up as recovery from the drought took place. But the export value fell back to US$7.5 million in 1999 despite a small volume increase. For the 1990s as a whole, the mean export value was US$5.9 million, little more than one-half the value in the 1980s. World prices contributed significantly to this result, especially to 1994 when they were around 50 per cent below price levels in the 1980s (Latukefu 1995:109).

The rubber export industry experienced an unprofitable first half of the decade, like many other agricultural exports, with export values varying between US$1.5 million and US$2.4 million from 1990 to 1996. The export value picked up to US$3.7 million in 1997 and held its ground in 1998, despite a fall in world price, as the drought ended and a new area of production came into operation (BPNG 1998:21). At US$2.0 million, it finished the study period still a long way from the values of around US$12 million in the 1960s.

As in the 1980s, no significant HVNT export industries emerged in agriculture in the final decade of the study period. A third short-lived revival occurred in the pyrethrum export industry in the early 1990s as the pyrethrum factory continued to operate under local government ownership, but export values were comparatively minor. Production of pyrethrum continued where alternative cash-cropping opportunities were lacking, mainly in Enga province (Fintrac 1986).

The chilli export industry failed to expand, despite its positive attributes, and recorded low export values in the 1990s. Its failure to persist as a major export industry can be attributed to marketing problems, its unattractiveness to pickers, handling and storage difficulties, and fluctuating and relatively low returns to labour (World Bank 1988). Cardamom exports also failed to revive in the 1990s despite possessing similar favourable attributes and without the harvesting problems of chillies. Low world prices were the major culprit, but inefficient public marketing and inadequate procedures in harvesting, curing, drying and grading, essential to obtain high prices (Fintrac 1986), also contributed.

2.3   Non-agricultural exports

2.3.1   1960s and 1970s

Papua New Guinea has relied almost exclusively on resource-based non-agricultural exports because economic conditions have not favoured the development of

manufactured exports. This situation has been due in large part to a high cost structure, exacerbated by inadequate infrastructure and poor workforce skills (Duncan 1995, Duncan and Lawson 1997). Also, various factors have discouraged foreign investment, such as insecure property rights, personal insecurity, distortionary trade and taxation policies, and public sector inefficiency (King and Sugden 1997:25). On the other hand, resource-based non-agricultural exports increased massively in the 1970s with the development of mineral exports and, to a lesser extent, marine and forestry exports. Mean non-agricultural export values increased almost ninefold such that the mean annual value of total exports increased fourfold during the decade. Copper and copper concentrate exports, which commenced in 1971 and averaged US$368.7 million per year, were the main contributor to this trend. A large copper and gold mine began operating at Panguna, Bougainville, in 1972.

Although their magnitude was much smaller than mineral exports, annual exports of forest products increased in mean value from US$8.1 million in the 1960s to US$32.9 million in the 1970s with the exploitation of Papua New Guinea's rich forest resources. The stochastic dominance of the 1970s was further enhanced by a decline in the coefficient of variation from 0.47 to 0.28. Log exports, which were the major component of this category of export, increased their mean annual value in a similar manner from US$4.3 million to US$22.2 million.

The domestic fisheries sector has concentrated on the high-value end of the market, mainly nearshore tuna, prawns, lobster, reef fish and deepwater sharks (AusAID 1997:72). Four local companies using pole-and-line vessels were operating during the 1970s, fishing inshore waters mainly for skipjack and juvenile yellowfin tuna (Waugh 1993:128). The mean value of marine exports increased from US$4.3 million in the 1960s to US$27.4 million in the 1970s, although the coefficient of variation also increased from 0.33 to 0.46. The increase in the mean value of exports in the 1970s had much to do with the operations of a major tuna pole-and-line fishing company operating out of Kavieng and Rabaul (AusAID 1997:72).

2.3.2   1980s

The values of mineral, forestry and marine exports continued to increase in the 1980s and were the reason why the 1980s dominated the 1970s in the value of total exports despite a reduced contribution from copper and copper concentrate exports. Overall, the mean annual export value of copper and copper concentrate was US$267.4 million, down a little over US$100 million on the mean annual value in the 1970s.

Export values of copper and copper concentrate drifted downwards from their 1979 level until 1984 as prices fell back. They then increased substantially from US$193 million in 1985 to US$480 million in 1988. Volumes increased moderately once the Ok Tedi mine commenced operations in 1984 (Parsons and Vincent 1991:19-20) to

boost the production and export of copper, gold and silver already coming from Panguna mine. But the main effect came from a doubling of prices from 1987 to record levels in 1988 after having remained depressed until 1986 (Dorrance, Liu and Woldekidan 1988:14-15). The export value finished the decade down somewhat at US$371 million following a fall in export volume and world price in 1989 (Dorrance, Liu and Woldekidan 1989:12-13).

Gold export values varied between US$244 million and US$273 million in the first five years of the decade before increasing to US$440.0 million in 1986. They were static in the second half of the decade despite still dominating copper exports until 1989 when, having fallen back in value to US$340.6 million, they were slightly eclipsed by copper. Both gold and copper exports were severely affected by an upsurge in violence associated with the Bougainville secession movement in North Solomons Province towards the end of 1988 that led to the closure of the Panguna mine in May 1989 (Cole, Dorrance and Weisman 1989:2). Prior to its closure, it 'had become the mainstay of the Papua New Guinea economy, accounting for nearly 10 per cent of GDP, 36 per cent of export earnings and 18 per cent of government revenue' (Parsons and Vincent 1991:19).

The mean export value of all forest products increased substantially in the 1980s, to US$93.8 million. The value had advanced from US$68.8 million in 1985 to US$110.8 million in 1987, an effect of both price and volume increases. It then declined to US$96.7 million by 1989, led lower mainly by a decline in export volume. Log exports continued to dominate and their average value more than trebled to US$75.7 million in the 1980s. The highest value reached during the decade was US$103.0 million in 1987, accounting for 93 per cent of forest products in that year. Despite accounting for 18 per cent of total forest product exports for the decade, other forest product exports followed log export values downwards in the final two years of the decade and contributed only 7.5 per cent of the value of all forest product exports in 1989.

Major concerns about the sustainability of the logging industry in Papua New Guinea led to the establishment by the government of the Commission of Inquiry into Forestry in 1987 (Government of Papua New Guinea 1989). In its report, the Commission detailed many problems facing the industry: corruption and fraud at all levels of government; transfer pricing (Hunt (2001:7) estimated it cost the economy 26-52 million kina in 1999); misdeclaration of species for export; inadequate state monitoring of practices; underreporting of export volumes; environmental destruction through bad logging practices; unsustainable logging practices; disregard of environmental and social guidelines; irregular or non-payment of levies by logging contractors; manipulation and cheating of resource owners; and abuse of power by ministers responsible for the forestry portfolio (Thompson 1994, Holzknecht and Kalit

1995:96-97). As Basil Fawlty responded to the litany of hotel hygiene infringements detailed by the health inspector: 'Otherwise OK?'.

Marine export values fell back in the 1980s, with the mean value down more than one-third to US$18.0 million and the coefficient of variation sharply up to 0.81. After being above US$40 million in 1980 and 1981, values fluctuated between US$9 million and US$14 million between 1982 and 1987 before declining further from 1987 to 1989, ending a disappointing decade at US$8.7 million. This decline was predominantly a function of export volume declines emanating from the closure of the domestic tuna fishery in 1985 (Vonole 1989:124). The tuna pole-and-line fishing venture, which had played a large part in the increase in exports during the 1970s, failed as a consequence of 'falling world market prices for tuna, high production costs and changes in the operational structures of the companies concerned' (AusAID 1997:72). This left the prawn fishery as the major marine export earner, with a maximum value for the decade of US$9.54 million in 1983, but in which problems of overfishing had begun to emerge by 1987 (Vonole 1989:128-129).

2.3.3   1990s

Despite events late in the decade that upset mineral exports in particular, such as the 1997-98 drought and falling international mineral prices following the Asian financial crisis (Yala and Levantis 1998:1), continued expansion of mineral and energy exports and the export of forest products in the 1990s ensured that this decade clearly dominated the 1980s for the values of total and non-agricultural exports. An increase in the coefficient of variation was strongly offset by an increase of 87 per cent in the mean value of non-agricultural exports.

During the 1990s, exports of copper and copper concentrate lost their supremacy as the premier export in the mineral and energy sector that they had wrenched from gold exports in 1989, when they accounted for 51 per cent of the value of mineral and energy exports. Three major internal events help to explain this turnaround: the substantial increases in values of gold and oil exports, and closure of the Panguna copper mine in 1989 (AusAID 1997:75-79). The relative contribution of copper to exports had fallen to 14 per cent by 1997. The decade was not without its 'thrills and spills', though. In the interim, the world price fell heavily between 1990 and 1993, rose rapidly by 1995, then fell by one-quarter over the next two years. A moderate increase in export volume from 196.5 kt to 215.7 kt occurred over the five-year period from 1990 to 1995, but it was followed by a massive decline to 77.8 kt in 1997. The copper export value gravitated to US$147.6 million in 1997, less than one-half its 1990 level of US$304.3 million and not much more than one-third the value of US$433.2 million in 1995. It finished the decade at US$225.2 million. Overall, the

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mean annual value for the 1990s was US$256.7 million, down 4 per cent on the mean value of US$267.4 million in the 1980s.

Crude oil exports led the charge in the expansion of non-agricultural exports during the decade, following the commencement of export by the Kutubu oil project in 1992 (Parsons and Vincent 1991:23). In that year, the export value was US$252 million, exceeding the combined value of all agricultural exports. It increased to US$622 million by 1996 before temporary closure forced by the drought in 1997 brought about a decline to US$484 million in that year as the export quantity diminished by almost 30 per cent to 27.97 million barrels from 39.31 million barrels in 1996. A recovery in 1999 led to a rise in export value to US$542.2 million, due largely to an increase of almost 10 per cent in export volume in that year. This increase was a product of the Gobe Main and Southeast Gobe oil projects coming on stream in mid-1998, more than offsetting a lower extraction rate from the wells in the Kutubu oil project (BPNG 1998:19). This increase in oil export volume was to be reversed in the first few years of the 21st century in line with expectations of declining yields at Kutubu.

The mean annual export value of gold increased from US$332.2 million in the 1980s to US$521.1 million in the 1990s, and the coefficient of variation went down from 0.26 to 0.19. Gold exports began the decade promisingly, almost doubling from US$341 million in 1989 to US$623.1 million in 1992, the highest value recorded thus far. This increase was a result of the commencement of operations of the Misima and Porgera gold mines in 1989 and 1990, respectively (Parsons and Vincent 1991:20-21, AusAID 1997:75). Export values were sluggish thereafter as production had peaked and decreasing head grade had set in at Porgera (Grynberg and Forsyth 1993:7). The export value declined to US$408.3 million in 1997 despite the fact that gold prices remained fairly constant. The drought in that year had forced temporary mine closures that caused a slight decline in the volume of gold production (BPNG 1998:19). Ok Tedi was particularly hit by the drought as production was halted when the level of the Fly River became too low to allow transport to and from the mine (Yala and Levantis 1998:3). Against this effect, operations at the Lihir mine commenced earlier than expected in 1997, enabling the gold export value to reach US$606.4 million by 1999, close to its all-time high value in 1992 and a touch off the second highest value of US$608.2 million recorded in the previous year. These high values were achieved despite a significant decline in the price of gold in 1998 and 1999, because the quantity of gold exports increased from 44.3 tonnes in 1997 to 63.0 tonnes in 1999.

Very large increases in the values of forest products were recorded in the 1990s, such that the mean annual value for the decade of US$196.0 million was more than double the 1980s average of US$93.8 million. The proportion of exports contributed by processed timber products fell from 9 per cent in 1989 to 5 per cent in 1999, but this does not tell the whole story because the proportion had risen in the interim to 18 per

cent in 1994. Ominously, however, the fact that logs had strengthened their relative contribution to timber exports by the end of the study period bodes ill for the future of the timber processing industry. Land tenure constraints have hampered efforts to develop sawmilling activities (Economic Insights 1994:51).

The increase in value of logs exported was far from consistent throughout the decade. Helped by an improvement in log quality (Callick 1991:10), it was moderate until 1992. The log export value reached US$123.8 million in that year, but had almost trebled to US$352.1 million by 1994. Export prices doubled in 1993, drawing a substantial increase in export volume, which was probably understated in the official statistics (Levantis and Livernois 1998:101). Values dropped back from this level until 1997 when they were US$246.3 million as volumes and real prices fell (even though nominal prices in kina remained largely unchanged). A calamitous decline occurred in 1998 when the export value reached US$85.8 million in the wake of plunging export volumes, which more than halved to 1.067 million cubic metres. This fall in volume was due to a decline in the demand for logs in East Asia in the wake of the Asian financial crisis, which led to the average export price almost halving from mid-1997 to mid-1998 (Levantis and Livernois 1998:100), and the completion of licensing agreements for some logging operations (BPNG 1998:21). Export volume recovered moderately to 1.312 million cubic metres in 1999 as prices picked up in the second half of the year. It was valued at US$104.7 million in that year, not a great deal above the mean value for the 1980s.

The fallout from the findings of the 1987 Commission of Inquiry into Forestry led to a new forestry policy and the 1991 Forestry Act (Holzknecht and Kalit 1995:96-97). But Holzknecht and Kalit (1995:98) considered the Forestry Act virtually ineffective as delays occurred in implementing a code of conduct embodied in the National Forestry Development Guidelines. Levantis and Livernois (1998:101) observed that the logging industry was still out of control in the early 1990s. They cited a study by Filer and Sekhran (1998) that concluded that a sustainable annual volume of timber exports would be around 2 million cubic metres, a figure far exceeded in the years from 1993 to 1997 even on the official export figures that are likely to understate export volumes.

A major impetus to domestic fishing occurred in 1994 with the launch of two large tuna purse seiners in Madang (AusAID 1997:72). Export volumes of marine products rose to 1995 but this did not lead to an increase in export value, which at US$9.0 million was one-half the value at the end of the previous decade. Despite a recovery by the small tuna fishing industry and an increase in the number of domestically licensed fishing boats from 45 to 130 from 1994 to 1997 (Manning 1997:13), export value had fallen to US$5.5 million in the latter year as one firm stopped operating. The value recovered sharply to US$20.9 million in 1998 with the resumption of

operation by the firm in question (BPNG 1998:21) before fading to US$11.9 million in 1999.

3.   Conclusions

A country with abundant natural resources, Papua New Guinea was able to experience significant growth in total export values throughout the final four decades of the 20th century, with each succeeding decade stochastically dominating the previous one. The expansion of mineral and energy exports from the early 1970s was the major source of this growth.

The powerful influence of an expanding minerals and energy sector must nevertheless be of concern in that this sector and other non-agricultural resource sectors comprise mainly extractive or quasi-extractive industries given the production practices that currently exist. Little progress has been made in diversifying into secondary and tertiary exports. Furthermore, prospects for the mineral and energy sectors do not look bright, with a collapse of exploration and development in the mining industry (Duncan 2001:11).

Growth also took place in agricultural export values during the study period. However, it was more modest than the growth in resource-based non-agricultural exports and confined mainly to the 1960s and 1970s.

References

Allen, B.J. 1993, 'Issues for the sustainability of agriculture systems in Papua New Guinea, 1990-2015', in *Issues in Papua New Guinea Agriculture*, Australian International Development Bureau, Canberra.

Anderson, D. 1978, 'Pyrethrum', in D.R.J. Densley (ed.), *Agriculture in the Economy: A Series of Review Papers, Volume 2*, Department of Primary Industry, Konedobu.

AusAID 1997, *Economic Survey of Papua New Guinea*, Australian Agency for International Development, Canberra.

BPNG 1998, *Quarterly Economic Bulletin: September 1998 Issue*, Bank of Papua New Guinea, Port Moresby.

BPNG 2000, *Quarterly Economic Bulletin*, 28(4) (and previous issues), Bank of Papua New Guinea, Port Moresby.

Callick, R. 1991, 'No blue skies yet in the South Pacific', *Pacific Economic Bulletin* 6(2):1-19.

Christensen, J. and Densley, D.R.J. 1978, 'Oil palm', in D.R.J. Densley (ed.), *Agriculture in the Economy: A Series of Review Papers, Volume 2*, Department of Primary Industry, Konedobu.

Cole, R., Dorrance, G.S. and Weisman, E. 1989, 'Current economic trends in selected South Pacific countries', *Pacific Economic Bulletin* 4(2):1-12.

DAL 1993, *Handbook on Agricultural Statistics 1992*, Policy Programming and Budgeting Division, Department of Agriculture and Livestock, Konedobu.

Densley, D.R.J., Rady, G.L. and Arnold, C.E.W. 1978, 'Rubber', in D.R.J. Densley (ed.), *Agriculture in the Economy: A Series of Review Papers, Volume 2*, Department of Primary Industry, Konedobu.

Dorrance, G.S., Liu, M. and Woldekidan, B. 1988, 'Individual primary commodity prices', *Pacific Economic Bulletin* 3(2):14-17.

Dorrance, G.S., Liu, M. and Woldekidan, B. 1989, 'Individual primary commodity prices', *Pacific Economic Bulletin* 4(1):11-15.

Duncan, R, 1995, 'Unit labour costs in manufacturing in Fiji and Papua New Guinea', *Pacific Economic Bulletin* 11(2):39-47.

Duncan, R, 2001, 'PNG economic survey: a scorecard for the Morauta administration', *Pacific Economic Bulletin* 16(2):1-14.

Duncan, R. and Lawson, T. 1997, *Cost Structures in Papua New Guinea*, Discussion Paper No. 69, Institute of National Affairs, Port Moresby.

Economic Insights 1994, *Papua New Guinea: The Role of Government in Economic Development*, International Development Issues No. 33, Australian International Development Assistance Bureau, Canberra.

Fairbairn, T.I.J. 1998, 'Economic consequences of natural disasters among Pacific island countries', *Pacific Economic Bulletin* 13(2):54-63.

Filer, C. and Sekhran, N. 1998, *Loggers, Owners and Resource Owners*, National Research Institute and International Institute for Environment and Development, Boroko and London.

Fintrac 1986, *Agricultural Marketing Support Services Project: Papua New Guinea*, Fintrac Consultants Asia Pte Ltd, Singapore.

Fleming, E.M. 1996, *Research Options for High-Value Agricultural Exports in South Pacific Island Nations*, Research Report 10, International Service for National Agricultural Research, The Hague.

Fleming, E. 1999a, *Estimates of Planted Areas and their Development Costs, Yields, Export Prices and Volumes, Exchange Rates and Price Support in the Tree Crop Industries in Papua New Guinea*, Occasional Paper 12, ACIAR Tree Crop Policy Options Project in Papua New Guinea, University of New England, Armidale.

Fleming, E. 1999b, *Assessment of the Impact of Policy Options on Profitability in the Tree Crop Industries in Papua New Guinea*, Occasional Paper 17, ACIAR Tree Crop Policy Options Project in Papua New Guinea, University of New England, Armidale.

Fleming, E.M. and Antony, G. 1993, *The Coffee Economy in Papua New Guinea: Analysis and Prospects*, Discussion Paper No. 55, Institute of National Affairs, Port Moresby.

Fleming, E. and Yala, C. 2001, *Policy Options for the Tree Crop Industries in Papua New Guinea*, Monograph No. 81, Australian Centre for International Agricultural Research, Canberra.

Government of Papua New Guinea 1989, *Commission of Inquiry into Aspects of the Forest Industry: Final Report*, Department of the Prime Minister, Port Moresby.

Grynberg, R. and Forsyth, D. 1993, 'Current economic trends in the South Pacific', *Pacific Economic Bulletin* 8(2):3-21.

Hardaker, J.B., Huirne, R.B.M. and Anderson, J.R. 1997, *Coping with Risk in Agriculture*, CAB International, Wallingford.

Holzknecht, H. and Kalit, K.K. 1995, 'Forest resources: what hope for the future?', *Pacific Economic Bulletin* 10(1):95-100.

Hunt, C. 2001, The contribution of forestry to development in selected Pacific island countries, Paper presented at the UNCTAD Workshop on Commodity-Based Development in Pacific Island Countries, Nadi, 18-20 September.

IMF 2002, *International Financial Statistics* (and previous issues), International Monetary Fund, Washington, D.C.

Ivarami, M. and Coulter, H. 1992, 'Regulatory functions and the performance of marketing authorities in the South Pacific', in E. Fleming and H. Coulter (eds),

Agricultural Export Marketing in the South Pacific: The Future Role of Marketing Authorities, Pacific Policy Paper 8, Australian National University, Canberra, 97-110.

Ivarami, M. and Yarbro, S. 1992, 'Cocoa grading and quality control in Papua New Guinea', in E. Fleming and H. Coulter (eds), *Agricultural Export Marketing in the South Pacific: The Future Role of Marketing Authorities*, Pacific Policy Paper 8, Australian National University, Canberra, 161-175.

King, T. and Sugden, C. 1997, 'Managing Papua New Guinea's kina', *Pacific Economic Bulletin* 12(1):20-29.

Levantis, T. and Livernois, J. 1998, 'Taking a piece of the pie: Papua New Guinea's log exports and optimal taxation', *Pacific Economic Bulletin* 13(2):99-116.

Manning, M. 1997, 'Developments in Papua New Guinea', *Pacific Economic Bulletin* 12(2):1-16.

McCarl, B.A. 1996a, RISKROOT program documentation, Department of Agricultural Economics, Texas A&M University, College Station. [http://ageco.tamu.edu/faculty/mccarl//riskclas/stodom.pdf]

McCarl, B.A. 1996b, Stochastic dominance notes, Department of Agricultural Economics, Texas A&M University, College Station. [http://ageco.tamu.edu/faculty/mccarl//riskclas/stodom.pdf]

McGregor, A. and McGregor, I. 1999, *Disaster and Agriculture in the Pacific Islands*, South Pacific Disaster Reduction Program, UN Department for Economic and Social Affairs, New York.

Munnull, J.P. 1973, *Survey Report on Smallholder Tea*, Department of Agriculture, Stock and Fisheries, Konedobu.

NCDS 1995, *South Pacific Economic and Social Database*, National Centre for Development Studies, Australian National University, Canberra.

NSO 1979, *Summary of Statistics 1979* (and earlier issues), National Statistical Office, Port Moresby.

Parsons, D. and Vincent, D. 1991, *High Stakes: Minerals and Petroleum Development in Papua New Guinea*, National Centre for Development Studies, Canberra.

Scoullar, B. 1973, *Pyrethrum and the Highlander*, Extension Bulletin No. 3, Department of Agriculture, Stock and Fisheries, Port Moresby.

Shaw, B. 1992, 'Pacific agriculture: a retrospective of the 1980s and prospects for the 1990s', *Pacific Economic Bulletin* 7(1):15-20.

Siwatibau, S. 1989, 'Current economic trends in selected South Pacific countries', *Pacific Economic Bulletin* 4(1):1-10.

Stapleton, G., Alu, M. and Wheeler, M. 1999, *Coffee Report No. 45*, Industry Affairs Division, Coffee Industry Corporation, Goroka.

Thompson, H. 1994, *The Forestry Industry and State Policy in Papua New Guinea: A Review*, Working Paper No. 103, Economics Department, Murdoch University, Perth.

Vance, P.N. 1987, *Agronomic Studies of Peanuts in Papua New Guinea*, Research Bulletin No. 42, Department of Primary Industry, Port Moresby.

Vonole, R. 1989, 'Management of the Papua New Guinea prawn fishery: an overview', in H. Campbell, K. Menz and G. Waugh (eds), *Economics of Fishery Management in the Pacific Islands Region: Proceedings of an International Conference Held in Hobart, Tasmania, Australia, 20-22 March 1989*, ACIAR Proceedings No. 26, Australian Centre for International Agricultural Research, Canberra, 124-129.

Waugh, G. 1993, 'Strategies for the development of fisheries', in *The Papua New Guinea Economy: Prospects for Sectoral Development and Broad Based Growth*, International Development Issues No. 30, Australian International Development Bureau, Canberra, 124-137.

World Bank 1982, *Papua New Guinea: Selected Economic Issues*, East Asia and Pacific Regional Office, Washington, D.C.

World Bank 1988, *Papua New Guinea: Agricultural Assessment Review—Volume 2 Annexes*, Washington, D.C.

Yala, C., Igitoi, J. and Lummani, J. 1999, *A Survey of the Impacts of Market Accessibility on the Behaviour of Smallholders and Buyers in Oil Palm Projects and Coffee-Producing Areas of Papua New Guinea*, Occasional Paper 18, Tree Crop Policy Options Project in Papua New Guinea, University of New England, Armidale.

Yala, C. and Levantis, T. 1998, 'Recent economic events in Papua New Guinea: a continuing drought in development', *Pacific Economic Bulletin* 13(2):1-28.

Appendix 1   Papua New Guinea Total Exports

SUMMARY STATISTICS ON THE DATA (US$ M)

Distribution	Mean	Std dev	Min	Max	RAC
1960s	245.73	75.58	164.80	407.10	
1970s	930.17	313.77	401.30	1396.40	0.0017
1980s	1070.02	151.31	830.10	1345.50	0.0010
1990s	1712.79	349.87	978.00	2150.50	0.0072

PAIRWISE RESULTS

THE BOUND READ IN FOR THE RAC LIMITS IT TO BETWEEN   .100000E

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   2 CALLED 1970s

THE DISTRIBUTIONS DO NOT CROSS --   2 IS DOMINANT

COMPARING DISTRIBUTION   1 CALLED 1960s

TO DISTRIBUTION   3 CALLED 1980s

THE DISTRIBUTIONS DO NOT CROSS --   3 IS DOMINANT

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   4 CALLED 1990s

THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPARING DISTRIBUTION   2 CALLED 1970s

TO DISTRIBUTION   3 CALLED 1980s

THE DISTRIBUTION CDFS CROSS   1 TIMES

3 HAS BEEN FOUND DOMINANT BETWEEN   .0000000000   .1000000000

A BREAKEVEN RAC =   -.0060463107 ABOVE WHICH DIST   3 DOMINATES

HERE THE UTILITY DIFFERENCE =   .00000000

COMPARING DISTRIBUTION   2 CALLED 1970s TO DISTRIBUTION   4 CALLED 1990s

THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPARING DISTRIBUTION   3 CALLED 1980s TO DISTRIBUTION   4 CALLED 1990s

THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPOSITE RESULTS

AT ALL RACS THE DOMINANT SET IS   4 1990s

Appendix 2   Papua New Guinea Agricultural Exports

SUMMARY STATISTICS ON THE DATA (US$ M)

Distribution	Mean	Std dev	Min	Max	RAC
1960s	179.62	52.50	112.10	268.70	
1970s	356.23	116.21	215.80	579.00	0.0037
1980s	314.48	67.30	240.70	469.00	0.0030
1990s	305.73	118.45	156.50	505.30	0.0032

PAIRWISE RESULTS

THE BOUND READ IN FOR THE RAC LIMITS IT TO BETWEEN   .100000E

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   2 CALLED 1970s

   THE DISTRIBUTIONS DO NOT CROSS --   2 IS DOMINANT

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   3 CALLED 1980s

   THE DISTRIBUTIONS DO NOT CROSS --   3 IS DOMINANT

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   4 CALLED 1990s

   THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPARING DISTRIBUTION   2 CALLED 1970s TO DISTRIBUTION   3 CALLED 1980s

   THE DISTRIBUTION CDFS CROSS   1 TIMES

   A BREAKEVEN RAC =   .0125432008 ABOVE WHICH DIST   3 DOMINATES

      HERE THE UTILITY DIFFERENCE = -.62712395E-15

COMPARING DISTRIBUTION   2 CALLED 1970s TO DISTRIBUTION   4 CALLED 1990s

   THE DISTRIBUTIONS DO NOT CROSS --   2 IS DOMINANT

COMPARING DISTRIBUTION   3 CALLED 1980s TO DISTRIBUTION   4 CALLED 1990s

   THE DISTRIBUTION CDFS CROSS   1 TIMES

 3 HAS BEEN FOUND DOMINANT BETWEEN   .0000000000   .1000000000

   A BREAKEVEN RAC = -.0018143740 ABOVE WHICH DIST   3 DOMINATES

      HERE THE UTILITY DIFFERENCE =   .00000000

COMPOSITE RESULTS

BELOW RAC =   .0125432008   THE DOMINANT SET IS 2 1970s

ABOVE RAC =   .0125432008   THE DOMINANT SET IS 3 1980s

Appendix 3   Papua New Guinea Non-Agricultural Exports

SUMMARY STATISTICS ON THE DATA (US$ M)

Distribution	Mean	Std dev	Min	Max	RAC
1960s	66.09	28.99	40.00	138.40	
1970s	573.94	250.04	144.50	1019.40	0.0031
1980s	755.54	159.23	589.40	1089.80	0.0015
1990s	1407.08	302.21	821.50	1912.20	0.0009

PAIRWISE RESULTS

THE BOUND READ IN FOR THE RAC LIMITS IT TO BETWEEN +/-   .100000E+00

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   2 CALLED 1970s

    THE DISTRIBUTIONS DO NOT CROSS --   2 IS DOMINANT

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   3 CALLED 1980s

    THE DISTRIBUTIONS DO NOT CROSS --   3 IS DOMINANT

COMPARING DISTRIBUTION   1 CALLED 1960s TO DISTRIBUTION   4 CALLED 1990s

    THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPARING DISTRIBUTION   2 CALLED 1970s TO DISTRIBUTION   3 CALLED 1980s

    THE DISTRIBUTIONS DO NOT CROSS --   3 IS DOMINANT

COMPARING DISTRIBUTION   2 CALLED 1970s TO DISTRIBUTION   4 CALLED 1990s

    THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPARING DISTRIBUTION   3 CALLED 1980s TO DISTRIBUTION   4 CALLED 1990s

    THE DISTRIBUTIONS DO NOT CROSS --   4 IS DOMINANT

COMPOSITE RESULTS

AT ALL RACS THE DOMINANT SET IS   4 1990s

Figure 1 Cumulative density functions, total exports: PNG
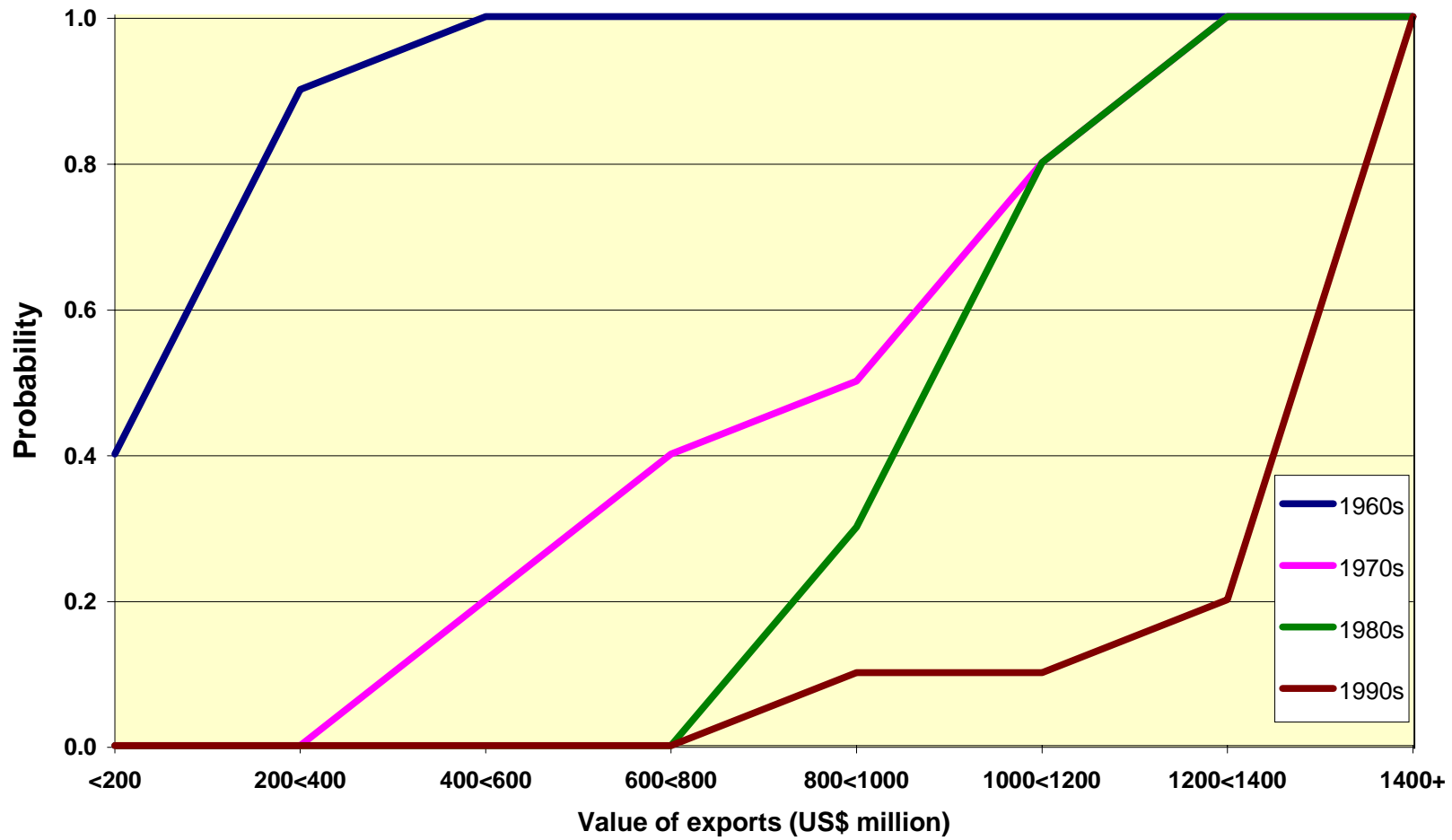
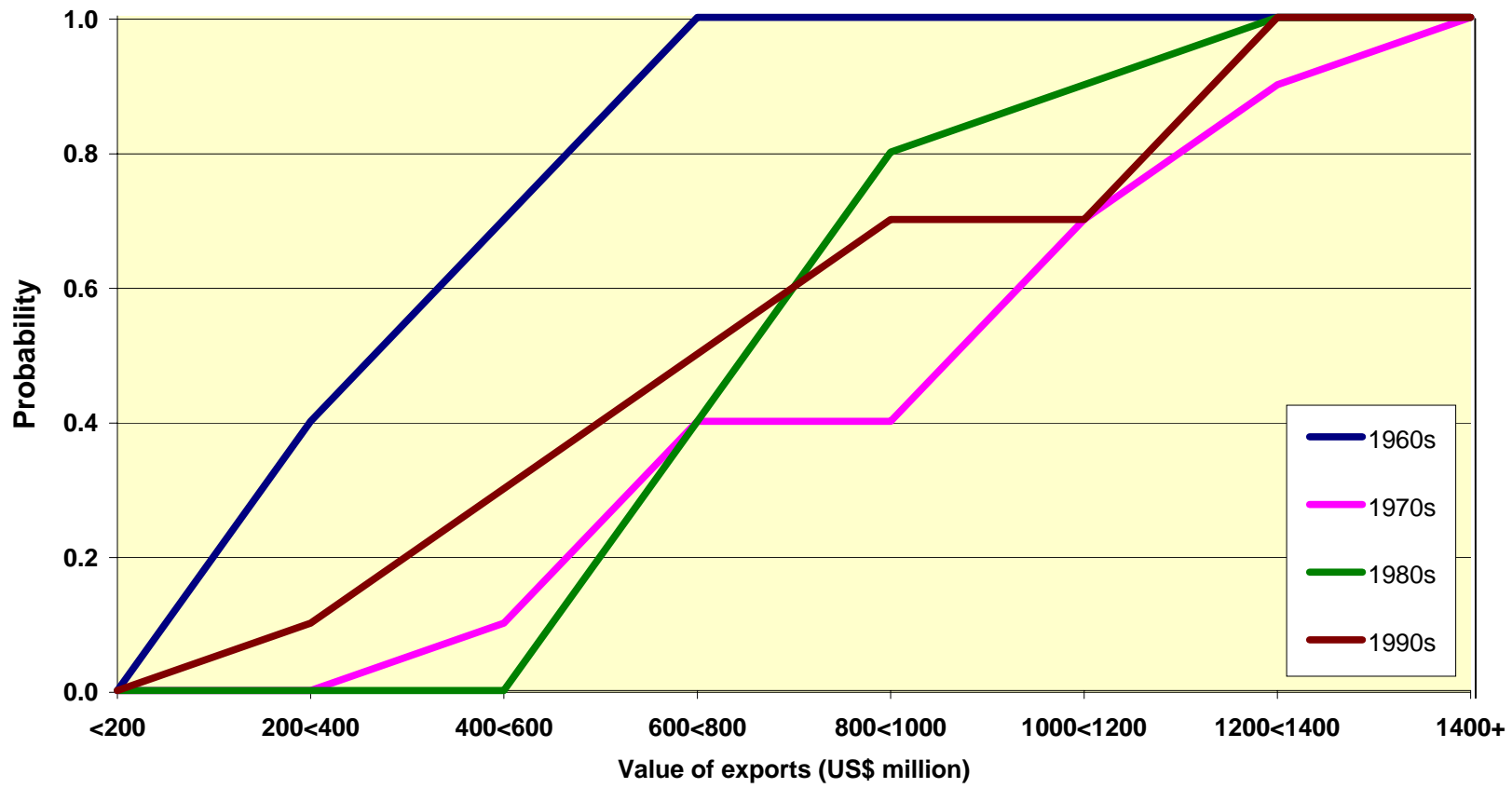**Figure 2 Cumulative density functions, agricultural exports: PNG**

Figure 3 Cumulative density functions, non-agricultural exports: PNG