# An analysis of policy changes affecting PNG cocoa producers

by

E Omuru*, R Fraser** and M Burton***

*PNG Cocoa and Coconut Research Institute, PO Box 1846, Rabaul, Papua New Guinea

**Faculty of Agriculture, University of Western Australia, Nedlands, Western Australia 6907

***School of Economic Studies, University of Manchester, Manchester M13 9PL, United Kingdom

Address for Correspondence: A/Professor Rob Fraser
Agricultural and Resource Economics
Faculty of Agriculture
University of Western Australia
Nedlands, Western Australia 6907

**ABSTRACT**

This paper assesses the welfare effects of a combination of policy changes affecting PNG cocoa producers during the 1990's. These policy changes are the introduction (in 1992) and intended removal (in 1997) of a price support policy plus an intervening devaluation and subsequent floating of the domestic currency (kina). Using a model for analysing the effects of these policy changes on a producer's price distribution and for converting these price effects into welfare effects, combined with price, cost and yield data from the PNG cocoa industry, it is shown that both the price support policy and the devaluation have been of benefit to producers. However, the devaluation has also diminished the effectiveness of the price support policy so that the negative consequences of its intended removal have been lessened.

## INTRODUCTION

In December 1992 the government of Papua New Guinea (PNG) introduced a price support policy for cocoa as a component of its Agricultural Price Guarantee Scheme (APGS). While previous policies were ostensibly aimed at income stabilisation, the aim of the new policy was to guarantee cocoa producers a minimum price of K1300 per tonne (Delivered-In-Store) at taxpayers expense (Omuru, 1996). Moreover, following the introduction of this policy, cocoa producers received further "price support" in the form of a 12% devaluation of the kina in September 1994 and its subsequent floating (October 1994). However, the guaranteed price policy is scheduled only to be effective for a period of five years and is due to be removed at the end of 1997.

Consequently, the period between 1992 and 1998 represents an interesting combination of policy impacts through the price mechanism on the welfare of PNG cocoa producers, and so the aim of this paper is to undertake an assessment of these welfare effects.

The structure of the paper is as follows. Section 1 sets out the model used for evaluating the welfare effects of the policy changes. This model is based on the formulae derived in Fraser (1988) for assessing the impact of a price support policy on a producer's price distribution. These formulae are combined with a simple representation of producer welfare which recognises the impact of such a policy on both the mean and variance of income.

In section 2 this model is combined with data from the PNG cocoa industry to evaluate the impact of each of the policy changes on producer welfare. In each case the direction of the welfare effect is shown to depend solely on the impact of the policy change on a cocoa

producer's expected price. However, the magnitude of this effect is also dependent on the level of risk aversion of the producer. In particular, because of the contrasting effects of each policy change on the variance of the producer price, more risk averse producers are shown to be relatively greater beneficiaries from the introduction of the price support policy, but relatively lesser beneficiaries from the devaluation of the kina. Finally, it is shown that the intervening devaluation of the kina has substantially diminished the prospective negative consequences for cocoa producers of the removal of the price support policy due at the end of 1997 The paper ends with a brief summary.

## SECTION 1: The Model

Following Fraser (1988) the impact of a price support policy on the mean and variance of a producer's (normal) price distribution can be represented as:

$$E(p) = F(p_s) \cdot p_s + (1-F(p_s))(\bar{p} + \sigma_p Z(p_s)/(1-F(p_s))) \quad (1)$$

$$\begin{aligned} Var(p) = {} & (1-F(p_s))\sigma_p^2 [1-(Z(p_s)/(1-F(p_s)))^2 \\ & + ((p_s-\bar{p})/\sigma_p)(Z(p_s)/(1-F(p_s)))] \quad (2) \\ & + F(p_s)(p_s-E(p))^2 + (1-F(p_s))(\bar{p} + \sigma_p Z(p_s)/(1-F(p_s))-E(p))^2 \end{aligned}$$

where: $p_s$ = support price

$F(p_s)$ = cumulative probability of actual price being less than the support price

$\sigma_p$ = standard deviation of the (domestic currency) world price distribution ($\sigma^2_p$ = variance)

$\bar{p}$ = mean of the (domestic currency) world price distribution

$Z(p_s) = \left(1/\sqrt{2\pi}\right)\exp[-0.5((p_s-\bar{p})/\sigma_p)^2]$.

In general terms these formulae show that the introduction of a price support policy will increase the expected producer price and decrease the variance of this price. By contrast, a devaluation of the domestic currency will shift the entire (domestic currency) world price distribution to the right. In so doing, the effective level of price support will drop, resulting in an increase in both the expected level and the variance of the producer price. Note however that, because of the existence of price support, the proportionate increase in the expected price will be smaller than the devaluation, while the extent of the increase in the variance of producer price will depend not only on the level of this support but also on any impact of the devaluation on the variance of the (domestic currency) world price distribution. For example,

if the devaluation is associated with an unchanged (international currency) world price distribution, then the devaluation will increase both the mean and the variance of the (domestic currency) world price distribution to the extent which preserves the coefficient of variation of this distribution.

Consequently, it can be seen that, for a risk averse producer, the introduction of a price support policy has an unambiguously positive welfare effect, whereas a devaluation has conflicting welfare effects through its impacts on the mean (positive) and variance (negative) of the producer price distribution. It follows that the size of the positive welfare effect from price support increases with the level of risk aversion, while the size of a positive welfare effect from a devaluation decreases with this level. A simple format for representing these various effects is the mean-variance model of the expected utility of profit ($E(U(\pi))$)[1]:

$$E(U(\pi)) = U(E(\pi)) + \tfrac{1}{2}U''(E(\pi)) \,.\, Var(\pi) \qquad (3)$$

where: $\pi$ = profit

$E(\pi)$ = expected profit

$Var(\pi)$ = variance of profit

$U(\pi)$ = utility of profit ($U'(\pi) > 0$, $U''(\pi) < 0$).

In addition, profit can be represented as:

$$\pi = p \,.\, q - c(q) \qquad (4)$$

where: $q$ = output

$c(q)$ = cost of production.

Consequently, if the cost and level of production are known with certainty, the mean and variance of profit are given by:

$$E(\pi) = E(p) \cdot q - c(q) \tag{5}$$

$$Var(\pi) = q^2 Var(p). \tag{6}$$

In the empirical analysis of the next section these assumptions are maintained, as is an assumption of constant returns to scale so that the analysis can be undertaken on a per hectare basis. In the context of PNG cocoa production the extent of yield uncertainty and economies of scale are considered to be sufficiently minor to warrant these simplifying assumptions.

## SECTION 2: Empirical Analysis

The first step in the empirical analysis is the estimation of the (domestic currency) world price distribution. The prices used in this study are monthly Delivered-In-Store (DIS) prices compiled and published by the Cocoa Board of Papua New Guinea from daily DIS prices quoted by major exporters at the warehouse. A total of 192 monthly observations (January 1974 to December 1989) were used to estimate the (domestic currency) world price distribution. Producer prices (DIS) for the period before 1974 are either unavailable or unreliable. In addition, the kina was subject to a 10% devaluation in January 1990, leaving the above period as the longest period of an undistorted relationship between domestic and world cocoa prices for which data are available.

On this basis the estimates of the mean and variance of (domestic currency) world cocoa prices for the period 1974 to 1989 are:

$$\bar{p} = 1381$$

$$\sigma^2_p = 178549 \qquad (CV_p = 30.6\%).$$

However, using these historical estimates with equations (1) and (2) to calculate the effect on the producer price distribution of the price support policy introduced in December 1992 (ie $p_s$ = 1300) is not straightforward. First, as mentioned above, the kina was devalued by 10% in January 1990. Second, it is widely held that average world cocoa prices have fallen since the high prices of the late 1970's and 1980's, both of which periods are included in our data set (see Figure 1). For example, a time series regression of the above-mentioned data forecasts a price of about 900 kina for 1993, even including the effects of the 1990 devaluation. Finally,

an econometric study by Hazell, Jaramillo and Williamson (1990) suggests a coefficient of variation of world cocoa prices of about 40% for a similar period to that referred to above.

Consequently, there is reason to believe that, in relation to the 1990's, the figures reported above based on the period 1974 to 1989 both overestimate the expected world price and underestimate the level of world price variability. Therefore, the approach taken here is to evaluate the welfare impact of the price support policy for various levels of expected world price and of world price variability. In this context Table 1 contains details of the evaluation of equations (1) and (2) to produce estimates of the impact of the introduction of the price support policy in December 1992 on the producer price distribution for three levels of expected world price ($\bar{p}$ = 1350, 1150 and 950) and two levels of the coefficient of variation of world price ($CV_p$ = 30% and 40%). The results in this table indicate that the price support policy is more effective in both increasing the expected producer price and decreasing the variability of this price the lower is the expected world price. In addition, a greater level of world price variability indicates a larger increase in the expected producer price with price support, while the associated degree of reduction in price variability also depends on the level of the expected world price.

To estimate the welfare effects of introducing the price support policy it is assumed that the producer's utility function of profit can be represented by the constant relative risk aversion form[2]:

$$U(\pi) = \pi^{1-R}/(1-R) \qquad (7)$$

where: $R = -U''(\pi)\,\pi/U'(\pi)$

= the producer's coefficient of relative risk aversion.

In addition, estimates for PNG of yield and cost of production per hectare are based on results contained in Department of Agriculture and Livestock/Cocoa Board (1991): *Costs of Production and Plantation Viability Survey*. The results used here relate primarily to more efficient largeholders:

$q$ = 1.3 tonnes/hectare

$c(q)$ = 1000 kina/hectare.

On this basis, and using equations (4), (5) and (6), estimates of the expected level and variance of profit both before and after the introduction of the price support policy are given in Table 2.

Evaluating equation (3) (having substituted equation (7)) using these before and after estimates for a range of attitudes to risk gives the welfare results reported in Table 3[3]. These results confirm the suggestion made in Section 1 that because price support both increases the expected producer price and decreases the variance of this price, the benefits of introducing such a policy are positively related to the level of risk aversion of the producer. They also confirm the indication in Tables 1 and 2 that the extent of producer benefit is inversely related to the expected world price and positively related to the level of world price variability.

Consider next the impact of the 12% devaluation of the kina in September 1994. On the basis that this devaluation did not change the coefficient of variation of (domestic currency) world cocoa prices, and focusing only on the initial expected world price level of 1150 kina, the post-devaluation estimates relating to the price distributions are given in the top part of Table 4. Note that while the devaluation has increased $\bar{p}$ by 12% ($CV_p$ unchanged), E(p) has only increased by 8.2% in the case of $CV_p = 30\%$ and 5.7% in the case of $CV_p = 40\%$. This reflects the dampening effect of the price support policy on the world price signal, an effect

which is stronger in the situation of greater world price variability where the price support policy has been shown to be more effective. Moreover, in connection with this finding notice that the overall effectiveness of the price support policy as measured by its impact on the CV of producer price has itself been reduced by the devaluation. For example, for a world price CV of 30%, the CV of producer price is 14.9% after devaluation compared with 10.9% before. This latter effect is apparent in the welfare impacts reported in the bottom part of Table 4 which show the extent of producer benefits from the devaluation diminishing with increases in the level of risk aversion of the producer. Notice also in this part of the table a reflection of the greater dampening effect of the price support policy on the benefits from the devaluation in the situation of greater world price variability.[4]

Consequently, it may be concluded that the producer benefits from a devaluation are diminished by the presence of the price support policy and that the extent of this diminution is positively related to the level of world price variability. However, it may also be concluded that a devaluation of the domestic currency erodes the benefits for producers of a price support policy, and that the extent of this erosion is positively related to the level of a producer's risk aversion.

Moreover, it follows from this conclusion that the welfare effects of the impending removal of the price support policy (November 1997) have been lessened by the intervening devaluation of the kina. In this context Table 5 contains estimates of the welfare effects of the removal of the price support policy for both the before and after devaluation situations (and for the two levels of world price variability). Although still indicating in each case a substantial negative impact on producer welfare, these results clearly show the erosion of the effectiveness of the price support policy associated with the September 1994 devaluation of the kina. Notice also

that the magnitude of the negative consequences for producers of the removal of price support are less sensitive to the level of world price variability following this devaluation of the kina. Finally, it should be noted that any additional depreciation of the kina associated with its floating in October 1994 will only dilute further the negative consequences for producers of the removal of the policy in 1997.

## CONCLUSION

The aim of this paper has been to assess the welfare effects of a combination of policy changes affecting PNG cocoa producers during the 1990's. These policy changes are the introduction (in 1992) and intended removal (in 1997) of a price support policy plus an intervening (in 1994) devaluation and subsequent floating of the domestic currency.

Section one presented a simple model for analysing the effects of the policy changes on a producer's price distribution and for converting these price effects into welfare effects. It was shown that the introduction of a price support policy increases the expected producer price but decreases the variance of this price, while a devaluation increases both the expected level and the variance of producer prices.

Section two used this model and price, cost and yield data from the PNG cocoa industry to analyse empirically the welfare effects of the policy changes. As expected it was shown that both the introduction of the price support policy and the devaluation of the domestic currency had beneficial welfare effects on producers. Moreover, in the former case the size of the benefits was positively related to the level of a producer's risk aversion, whereas in the latter case the size of the benefits was negatively related to this level.

However, it was also shown that a devaluation reduces the effectiveness of a price support policy by diminishing both its positive impact on expected producer price and its negative impact on the variance of producer prices. Therefore, it was concluded that the negative welfare effects of the impending removal of the PNG cocoa price support policy in December 1997 have been lessened by the intervening devaluation of the kina although the magnitude of

these effects is still likely to be substantial. Moreover, any additional depreciation of the kina associated with its floating in October 1994 will further expose cocoa producers to world price variability, while at the same time diminishing the likelihood of price support being invoked. It follows that by the time of its removal the welfare effects of the cocoa price support policy may have been considerably eroded by intervening exchange rate policy decisions.

## REFERENCES

Cocoa Board of Papua New Guinea (1996) *Cocoa Statistics of Papua New Guinea* Rabaul: Cocoa Board.

Department of Agriculture and Livestock/Cocoa Board (1991) *Costs of Production and Plantation Viability Survey, Final Report* Port Moresby: Department of Agriculture and Livestock, Cocoa Board and ANZDEC Ltd.

Fraser, R.W. (1988) "A method for evaluating supply response to price underwriting" *Australian Journal of Agricultural Economics* 32(1):22-36.

Hanson, S.D. and Ladd, G.W. (1991) "Robustness of the mean-variance model with truncated probability distributions" *American Journal of Agricultural Economics* 73(2):436-45.

Hazell, P.B.R., Jaramillo, M. and Williamson, A. (1990) "The relationship between world price instability and the prices farmers receive in developing countries" *Journal of Agricultural Economics* 41(2):227-41.

Newbery, D.M.G. and Stiglitz, J.E. (1981) *The Theory of Commodity Price Stabilisation* Oxford, Clarendon Press.

Omuru, E. (1996) *An Evaluation of the Welfare Effects of the Papua New Guinea Government's Cocoa Price Support Policy Since 1993* MA(Econ) Dissertation, University of Manchester.

Pope, R.D. and Just, R.E. (1991) "On Testing the Structure of Risk Preferences in Agricultural Supply Analysis" *American Journal of Agricultural Economics* 73(3): 743-8.

## FOOTNOTES

1 See Hanson and Ladd (1991) for arguments supporting the use of this framework in empirical analysis, even in the context of truncated probability distributions such as applies here.

2 See Pope and Just (1991) for arguments supporting the use of this functional form.

3 This range of values of R is consistent with evidence reported by Newbery and Stiglitz (1981).

4 A similar pattern of results is apparent for the other levels of expected world price. The only difference is that for a lower expected world price the dampening effect is also greater. Consequently, these results are not reported here.

**Table 1**

**Estimates of the Impact of the Cocoa Price**

**Support Policy on the Producer Price Distribution**

| | Coefficient of Variation of World Price ($CV_p$) | |
|---|---|---|
| Expected World Price | 30% | 40% |
| 1350 | | |
| E(p) | 1487.8[a] | 1541.3[b] |
| Var(p) | 64203.2 | 110197.6 |
| CV | 17.0 | 21.5 |
| 1150 | | |
| E(p) | 1375.4[c] | 1418.2[d] |
| Var(p) | 22502.1 | 47070.6 |
| CV | 10.9 | 15.3 |
| 950 | | |
| E(p) | 1315.1[e] | 1336.7[f] |
| Var(p) | 3402.0 | 11580.6 |
| CV | 4.4 | 8.1 |

Notes: a $\sigma^2_p$ = 164025

b $\sigma^2_p$ = 219600

c $\sigma^2_p$ = 119025

d $\sigma^2_p$ = 211600

e $\sigma^2_p$ = 81225

f $\sigma^2_p$ = 144400

**Table 2**

**Estimates of Expected Profit and Variance**

**of Profit Before and After Price Support**

| Expected World Price | | Coefficient of Variation of World Price | | | |
|---|---|---|---|---|---|
| | | 30% | | 40% | |
| | | Before Price Support | After Price Support | Before Price Support | After Price Support |
| 1350 | | | | | |
| | $E(\pi)$ | 755.0 | 934.1 | 755.0 | 1003.7 |
| | $Var(\pi)$ | 277202.3 | 108503.4 | 492804.0 | 186233.9 |
| 1150 | | | | | |
| | $E(\pi)$ | 495.0 | 788.1 | 495.0 | 843.6 |
| | $Var(\pi)$ | 201151.3 | 38028.6 | 357604.0 | 79549.3 |
| 950 | | | | | |
| | $E(\pi)$ | 235.0 | 709.6 | 235.0 | 737.7 |
| | $Var(\pi)$ | 137270.3 | 5749.4 | 244036.0 | 19571.2 |

**Table 3**

**Estimates of the Welfare Effects**

**of Cocoa Price Support[a]**

| Expected World Price | | R | | | |
|---|---|---|---|---|---|
| | | 0 | 0.25 | 0.5 | 0.75 |
| 1350 | | | | | |
| | $CV_p = 30\%$ | 23.7 | 29.6 | 35.9 | 42.3 |
| | $CV_p = 40\%$ | 32.9 | 45.4 | 59.5 | 73.8 |
| 1150 | | | | | |
| | $CV_p = 30\%$ | 59.2 | 75.8 | 94.7 | 114.3 |
| | $CV_p = 40\%$ | 70.4 | 104.5 | 147.9 | 194.3 |
| 950 | | | | | |
| | $CV_p = 30\%$ | 202.0 | 329.5 | 533.7 | 768.9 |
| | $CV_p = 40\%$ | 213.9 | 537.7 | 1452.6 | 2531.4 |

Notes: a Results are report in terms of the percentage change in the certainty equivalent of income. This is the value of $\pi$ such that: $\pi^{1-R}/(1-R)=E(U(\pi))$ in equation (3). This is a scale free measure.

**Table 4**

**Estimates of the Impact of the 12% Devaluation of the Kina in September 1994[a]**

A Price Impacts

| | Coefficient of Variation of World Price | |
|---|---|---|
| | 30% | 40% |
| $\bar{p}$ | 1288.0 | 1288.0 |
| $\sigma^2_p$ | 149305.0 | 181135.4 |
| E(p) | 1488.2 | 1499.6 |
| Var(p) | 49056.3 | 88024.3 |
| CV | 14.9 | 19.8 |

B Welfare Impacts[b]

| | R | | | |
|---|---|---|---|---|
| | 0 | 0.25 | 0.5 | 0.75 |
| $CV_p = 30\%$ | 18.6 | 18.1 | 17.6 | 17.1 |
| $CV_p = 40\%$ | 12.5 | 11.8 | 11.0 | 10.3 |

Notes: a Based on an initial expected world price = 1150 Kina.

b Percentage change in the certainty equivalent of income.

**Table 5**

**Welfare Effects of the Removal of the**

**Cocoa Price Support Policy[a,b]**

| | R | | | |
|---|---|---|---|---|
| | 0 | 0.25 | 0.5 | 0.75 |
| $CV_p = 30\%$ | | | | |
| Before Devaluation | -37.2 | -43.1 | -48.6 | -53.3 |
| After Devaluation | -27.9 | -32.0 | -36.0 | -39.6 |
| $CV_p = 40\%$ | | | | |
| Before Devaluation | -41.3 | -51.1 | -59.7 | -66.0 |
| After Devaluation | -29.0 | -33.5 | -37.9 | -41.8 |

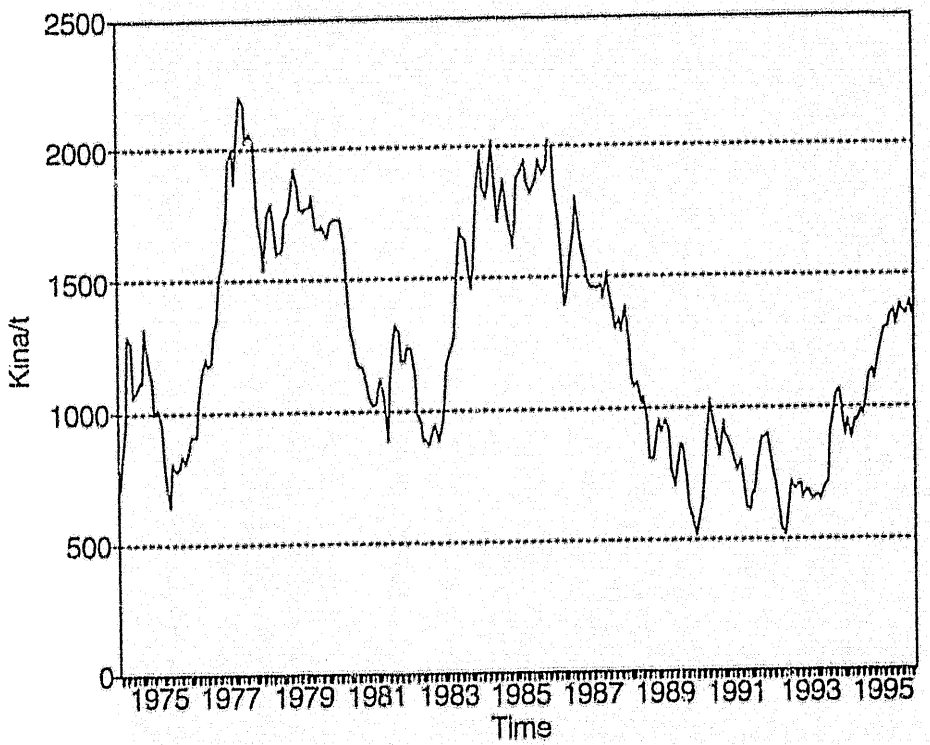
Notes: a Based on an initial expected world price = 1150 Kina.

b Percentage change in the certainty equivalent of income.

**Figure 1**

**Monthly Delivered-In-Store**

**Cocoa Prices 1974-1995**




Source: Cocoa Board of Papua New Guinea