

PRODUCTION RESPONSE TO PRICES IN THE COCONUT INDUSTRY OF PAPUA NEW GUINEA: A COMMENT ON THE METHODOLOGY AND A RE-ESTIMATION

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Introduction

Analytical studies on the supply response of growers in the major crop sectors in Papua New Guinea (PNG) are scarce. For this reason, De Silva, Kiele and Lagap (DKL, 1987)² must be congratulated for their pioneering attempt at analysing the production response to changes in prices in the coconut sector of the country. However, in their analysis there are several short-comings of a methodological and empirical nature. The purpose of this note is to highlight these shortcomings and offer alternative estimations and interpretations about the nature of production response to price changes in the coconut sector.

DKL's Estimates And Their Shortcomings

DKL specified the following supply function to analyze the production response of coconut growers:

$$Y = f(P, T, A) \quad (1)$$

where Y is copra output, P is price of copra, T is the time trend variable and A is a dummy variable included to account for structural change in production organization in the coconut sector (from large holder dominance to small holder dominance since 1977).

In the presentation of the results, the variable A has been dropped by DKL because of the statistically insignificant coefficient attached to this variable. The equations estimated by DKL with price lagged on (P_{t-1}), seven (P_{t-7}), and eleven (P_{t-11}) years are reproduced below

$$\text{Log } Y = 5.0141 + 0.012942 \text{ Log } P_{t-1} + 0.0001 T \quad (2)$$

$$\text{Log } Y = 5.0082 + 0.00011 \text{ Log } P_{t-7} + 0.00632 T \quad (3)$$

$$\text{Log } Y = 5.0225 + 0.00017 \text{ Log } P_{t-11} + 0.0064 T \quad (4)$$

Based on the above equations, DKL calculated the short-run price elasticity of supply at 0.012942 (equation 2), a "medium-term" price elasticity of 0.00011 (equation 3) and a "long-term" price elasticity of 0.00017 (equation 4).

DKL have estimated different specifications of their basic supply function with price lags ranging from 1 to 15 years. In doing so, DKL have implicitly assumed that coconut growers make supply decisions in the current time period according to price received by them for copra even 15 years ago. Whatever the price lag chosen, the model employed by DKL only allows an estimation of *short-run supply* response and hence short-run price elasticity of supply. The inclusion of price lagged 7 years or 15 years does not permit one to estimate *long-run supply* response or long-run price elasticities; they still show the short-run response. Thus, DKL have erred in calling the elasticities they calculated on the basis of estimated equations with price lagged 7 years and 11 years the "medium-term" and "long-term" elasticities, respectively. Subject to errors of the Consumer Price

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² De Silva N.T.M.H., Kiele L.J. and Lagap A.F. (1987) 'Production Response to Prices in the Coconut Industry of Papua New Guinea', CORD Vol. III No. 2 July 1987 pp. 2-20.

Index data used (see below), the equation with a price lagged one year (equation 2) provides DKL's "best" estimate of the short-run supply elasticity other two equations are quite unnecessary.

The inclusion of the dummy variable (A) in the supply function (equation 1) only allows one to estimate two supply functions with different intercepts for the two periods considered: from 1962 to 1976 and from 1977 to 1985. It does not provide a basis to infer anything about different supply responses or short-run price elasticities in different situations of small holder dominance viz-a-viz large holder dominance. It appears that DKL believe that these different supply responses can be analysed by the inclusion of an intercept dummy in the supply response equation. This is another shortcoming of the DKL's analysis. To analyse the different supply responses in the two periods one must reestimate the supply functions with slope dummies with respect to the price variable.

Another problem with DKL's estimation concerns the Consumer Price Index (CPI) data used to deflate the price of copra. Although DKL claim that year 1985 was used as the base, it appears that the indices given on different bases (e.g. 1962= 100, 1971= 100 and 1977= 100) have not been converted to a common basis (i.e. 1985=100). Thus, the CPI data used by DKL exhibit quite unacceptable swings: for example, from 82.82 in 1973 to 103.9 in 1974 and from 127.20 in 1977 to 62.27 in 1978. The use of these apparently inaccurate CPI data must have seriously affected the elasticity estimates made by DKL.

Analysis of Long-run Supply Response

Analysis of long run supply response and the estimation of long run price elasticities of supply require specification of a different supply function which takes in account the process of continuous adjustment of output by producers towards a long-run equilibrium. The long-run adjustment process can be analysed by employing "Nerlovian adjustment lag model" (Nerlove, 1958), which includes lagged output as an independent variable in addition to price of output. The lagged output term serves as a proxy for all previous adjustments to prices. An additional argument is that current output depends also on the output in the previous period. This is so because in the short-run, an instantaneous adjustment of output to a change in price is constrained by factors such as "...resource fixity, managerial ability of farmers, and habitual production patterns" (Tamek and Robinson, 1982, p. 316).

When a supply function is estimated with price (P) and lagged output (Y_{t-1}) variables, the short-run supply response is indicated by the coefficient estimated for the price variable, but the long-run supply response (adjustment) is larger by a factor determined by the estimated coefficient for lagged output variable. Therefore, the degree of adjustment (coefficient of adjustment) is determined by subtracting the coefficient for lagged output variable from one. To derive the long-run price elasticity, the short-run price elasticity is divided by the coefficient of adjustment. Formally, the procedure is as follows :

Step 1: Estimate the supply response equation

$$y_t = a + bP + cY_{t-1} \quad (5)$$

Step 2: Calculate the Coefficient of adjustment (r)

$$r = 1 - c(Y_{t-1})$$

Step 3: Calculate the short-run price elasticity (es)

$$es = b (P/Y) \text{ (for linear function)}$$

$$es = b \text{ (for log-linear function)}$$

Step 4: Calculate the long-run price elasticity (el):

$$el = es/r$$

One would normally expect a coefficient of adjustment of greater than zero and less than one, implying a partial adjustment. Zero coefficients are ruled out because they imply infinite long-term price elasticities with finite short-run price elasticities, while unitary coefficients are unacceptable since it is not reasonable to expect a perfect adjustment where desired or expected output exactly equals actual or realised output.

A common result is that long-run elasticity is roughly twice as large as the short-run elasticity. DKL calculate a smaller "longterm" elasticity and provide explanations as to why this may be possible. But the real problem is the snag in their method of estimation.

Re-estimation of Copra Supply Functions

First, the copra supply function as specified by DKL was re-estimated, using price and quantity data provided in DKL's paper. However, the prices were deflated by a re-chained Consumer Price Index (1985 = 100; see Appendix 1). Since CPI data for this index were available from 1962, and because of the inclusion of one year lag, the period of the analysis is confined to 23 years from 1963 to 1985 (see Appendix 2). As in DKL paper, the log-linear functional form was employed in the statistical estimation.

A preliminary run of the regressions indicated that, as in DKL's estimation, the coefficient attached to the dummy variable (A) was not statistically significant even at 10 per cent level. Hence it was decided to drop this variable from the subsequent specifications. Only the results of the estimations without the variable A are reported below.

Supply Function: $\log Y_t = f(\log P_{t-1}, T)$ (6)

	Coefficient	t statistic
Constant	4.612	35.36
$\log P_{t-1}$	0.158	3.37
T	0.008	9.01

$R^2 = 0.82$, $R^2 = 0.80$, $F = 44.25$, $D.W. = 1.63$

All the coefficients are significant at 1 per cent level.

In equation (6), Y_t is current copra production in tonnes, p_{t-1} is copra price lagged one year (Kina/tonne) deflated by Consumer Price Index (1985= 100), and T is time trend variable which is included to account for the effects of new plantings and replantings on the supply over the period considered.

The short-run price elasticity of 0.158, estimated on the basis of equation (6), represents a remarkable improvement over the DKL estimate. The estimate of price elasticity indicates that, in the short-run, a 10 per cent increase in price leads to about 1.6 percent increase in copra production. Thus it is reasonable to conclude that price responsiveness of coconut growers in PNG is much higher than that implied in DKL paper, although in technical terms copra production is still "inelastic" with respect to price.

To examine whether there is any difference of supply elasticities between the periods prior to 1977 and after 1977, another equation was estimated including slope dummies with respect to the price variable. The results of this estimation are reported below.

$$\text{Supply Function: } \log Y_t = f(\log P_{1,t-1}, \log P_{2,t-1}, T) \quad (7)$$

where, $P_{1,t-1} = 1 \times P_{t-1}$ for 1963-76

$= 0 \times P_{t-1}$ for 1977-85, and

$P_{2,t-1} = 0 \times P_{t-1}$ for 1963-76

$= 1 \times P_{t-1}$ for 1977-85.

	Coefficient	t Statistic
Constant	4.607	34.93
$\log P_{1,t-1}$	0.164	3.439
$\log P_{2,t-1}$	0.17	3.46
T	0.007	5.225

$$R^2 = 0.82, R^2 = 0.79, F = 29.4, D.W. = 1.653$$

All the coefficients are significant at 1 per cent level.

On the basis of the above results, the short-run price elasticities of supply are estimated at 0.164 for the period 1963-76 and at 0.17 for the period 1977-85. The absolute magnitudes of price elasticities are not very different from each other. Thus the results indicate that growers' response to price changes has not been significantly higher after -small holdings gained dominance in the coconut production sector.

Finally, another specification of the supply function including the lagged output variable (Y_{t-1}). was estimated. Since the time trend variable, T, and Y_{t-1} were highly correlated with each other, the variable T was dropped from this specification. This exclusion is justified as usually Y_{t-1} serves as a proxy for T.

An estimation of this final specification without the intercept dummy (A) lead to a negative coefficient of the price variable. Hence it was decided to include A in this specification. The results of the modified estimation are as follows:

$$\text{Supply Function: } \log Y_t = f(\log P_{1,t-1}, \log Y_{t-1}, A) \quad (8)$$

	Coefficient	t statistic
Constant	2.206	2.475
$\log P_{1,t-1}$	0.081	1.339
$\log Y_{t-1}$	0.535	3.067
A	-0.055	-2.747

$$R^2 = 0.71, R^2 = 0.66, F = 15.5.$$

Constant term is significant at 2.5 per cent level. The coefficient for $\log P_{1,t-1}$, is significant at 10 per cent level. Coefficients for $\log Y_{t-1}$ and A are significant at 1 per cent level.

As can be seen, the statistical fit of equation (8) is lower than that of equations (6) and (7). Also, the level of significance of the coefficient for price variable has reduced. However, the coefficient for lagged output variable is significant at 1 per cent level. On the basis of the above results, the short-run price elasticity of supply is calculated at 0.081, the "coefficient of adjustment" at 0.465 (1-0.535), and the long-run price elasticity of supply at 0.17. The estimates show that current supply of copra depends more significantly on the level of supply in the previous year than on the price in the previous year, that growers are slow in making adjustments to supply in response to changes in prices, and that the level of annual supplies has been slightly lower before the mid 1970s when large holders dominated the coconut production sector compared to the level of supplies after mid 1970s when small holders gained dominance.

Conclusion

It is clear from the foregoing discussion that DKL's estimates of price elasticities of copra supply in PNG are unacceptable mainly because of the inaccuracy of Consumer Price Index data used by them to deflate the producer prices. Also the methodology employed by DKL to estimate long-run price elasticities of supply and to analyse supply response in different situations of large holder and small holder dominance in the coconut sector is not appropriate.

The following conclusions emerge from the reestimation of copra supply response functions undertaken in this note: (1) The short-run price responsiveness of PNG coconut growers is much higher than that implied in DKL's estimates. For example, the estimates presented in this note (equation 6) show that a 10 per cent increase in price would result in 1.6 percent increase in copra production, whereas DKL conclude that a similar change in price would lead to 0.1 percent increase in production. (2) Growers are slow in making adjustments to supply in response to changes in prices, perhaps caused by the delays in receiving up to date price information. (3) It is reasonable to believe that annual copra supplies have been slightly higher after mid 1970s with small holdings gaining dominance in the coconut production sector and associated expansion of acreage under coconut cultivation.

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APPENDIX 1 : Consumer Price Index Data Used in the Present Estimation

The Retail Price Index published in the *Statistical Bulletin* of 1972 by the Bureau of Statistics of the Territory of Papua and New Guinea, has the base year of 1962, and are given on June-May basis. These, data, were converted to calendar year on pro-rata basis. The converted series are as follows

Year	Index
1962	100
1963	98.15
1964	100.60
1965	105.40
1966	110.15
1967	113.0
1968	114.35
1969	113.85
1970	115.52
1971	123.2

The Abstracts of Statistics published by the Bureau of Statistics for various years during 1972-77 give CPI data taking 1971 as the base year. The CPI figures for 1971-77 are as follows

Year	Index
1971	100
1972	106.07
1973	114.92
1974	141.55
1975	156.40
1976	168.37
1977	176.00

The above figures are the annual averages of quarterly figures given in the Abstracts of Statistics.

The following CPI figures were extracted from *Abstracts of Statistics/Statistical Bulletins* published by the National Statistical Office during 1981-85. The data has 1977 as the base year

Year	Index
1977	100
1978	105.8
1979	111.9
1980	125.4
1981	135.5
1982	143.0
1983	154.3
1984	165.8
1985	171.9

The different series were converted to a common base year (1985= 100), applying the simple straight line conversion method. The conversion was in several steps. First, figures from 1962 to 1970 were converted for 1971=100. Second, figures from 1962 to 1976 were converted setting 1977=100.

FinaUy, the figures from 1962 to 1984 were converted for the base where 1985=100. The converted CPI figures, which were used in deflating producer price are as follows

Year	Index
1962	26.30
1963	25.82
1964	26.45
1965	27.72
1966	28.97
1967	29.72
1968	30.07
1969	29.94
1970	30.38
1971	32.48
1972	34.44
1973	37.32
1974	45.97
1975	50.79
1976	54.68
1977	58.00
1978	61.36
1979	64.90
1980	72.73
1981	78.59
1982	82.94
1983	89.49
1984	96.16
1985	100

APPENDIX 2 : Copra Production and Price Data Used in the Estimation.

Year	Production (Tonnes)	Nominal Producer Price (Kina/Tonne)
1962	110,639	118
1963	106,696	134
1964	114,339	144
1965	122,340	171
1966	114,209	137
1967	115,211	148
1968	136,556	171
1969	128,444	146
1970	128,947	163
1971	137,827	142
1972	131,736	113
1973	125,438	197
1974	137,236	368
1975	139,369	165
1976	123,252	174
1977	134,004	237
1978	145,927	252
1979	160,136	344
1980	148,373	249
1981	146,867	223
1982	138,128	172
1983	137,527	240
1984	158,224	387
1985	175,833	310

Source: De Silva, Kiele and Lagap (1987), P. 10.