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Commodity price stabilisation: macroeconomic impacts and policy options

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Abstract

A macroeconometric simulation study is undertaken to evaluate the impact of commodity price stabilisation (CPS) schemes for the export tree crop industry in Papua New Guinea. The findings suggest that there is a negligible level of favourable macroeconomic impacts of CPS. Contrary to the expectation, CPS adversely affects the stability of monetary and external sectors (BOP). CPS policy has failed to stabilise the macroeconomy. The price stabilisation policies are no longer appropriate from the macroeconomic point of view. Technical change, futures market and rural savings are the possible alternative policy options to manage the price risk. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

In Papua New Guinea (PNG), major tree crop exports (coffee, cocoa, copra, coconut oil and palm oil) provide approximately US$ 270 million of annual exports. These exports contribute to 95% of agricultural exports and 16% of total exports. About 75% of the households in PNG are producers of major tree crop exports and the tree crop industries contribute substantially to the economic welfare of about 85% of the population in PNG (DAL, 1995). The tree crop exports is therefore crucial for economic development in PNG.

The tree crop exports fluctuate by an annual average of 30% and the fluctuations are mainly due to the commodity prices. Commodity price stabilisation (CPS) schemes were introduced with the objectives to stabilise the prices paid to growers and to contribute to economic stability. CPS schemes have been part of the tree crop industry policy for more than three decades and they have been an integral part of the government's macroeconomic policy framework in order to minimise the adverse macroeconomic impacts of tree crop export instability (Department of Finance and Planning, 1982).

The CPS schemes operated in the tree crop industries of PNG are examples of the buffer funds method of managing price instability. The stabilisation fund accumulates revenues collected as levies when the prices of export commodities are above the threshold price and disburses the revenue accumulated as bounties when the prices fall below the threshold prices. On several occasions, government-guaranteed commercial bank loan funds were used to replenish the funds. CPS schemes were self-financing until 1989

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but a continuous decline in world commodity prices in the 1980s, without a comparable shift downward in the reference price paid to producers, led to the complete exhaustion of stabilisation funds in the year 1992 (from the level of K 175 million in 1986–1987). By 1990, the commodity stabilisation could not operate under the bounty–levy system. The Minister for Treasury and Corporate Affairs indicated that the Government involvement in stabilisation activities would be eliminated (Department of Treasury and Corporate Affairs, 1998).

The government of PNG is in the process of evaluating the CPS schemes and examining various policy options. The present study is undertaken to evaluate the macroeconomic impacts of the CPS schemes in PNG. Developing economies of Asia, Africa and Latin America, where the tree crop export commodities still account for the bulk of their exports, are facing a similar problem of managing commodity price stabilisation policies. The present study provides empirical evidence that might facilitate in price policy analysis. The findings will be of great interest to policy planners of developing economies.

2. Evaluation of price stabilisation

Critics of price stabilisation (Newbery and Stiglitz, 1981; Piggott et al., 1986; Fleming and Piggott, 1989) argued that price stabilisation failed to offset fluctuations in the macroeconomy. Advocates of price stabilisation (SPC, 1980; Garnaut and Baxter, 1984; Manning, 1987) are of the view that price stabilisation has been effective in reducing the macroeconomic instability. Newbery and Stiglitz (1981) showed that it is possible that at least some of the developing countries would actually be worse off as a result of stabilisation and the major beneficiaries might be importing developed countries. Kaldor (1987) discussed the importance of stabilised incomes of primary producers on the rate of growth of demand for manufactured goods and services. Evidence shows that the prices of the major traded primary commodities exhibit significant annual serial correlation that dramatically affects the feasibility of price stabilisation (Kletzer et al., 1991). 'Government intervention to stabilise commodity prices and reduce uncertainty has been often ineffective and costly' (Varangis and Larson, 1996).

A number of studies have been conducted of the CPS schemes in PNG, the findings of which are reported here. Kiele (1986) reported that, from a macroeconomic point of view, stabilisation policy complements the normal fiscal and monetary policies to ensure macroeconomic stability. Jarrett and Anderson (1989) concluded that these schemes contribute little towards stabilising the macroeconomy, which is one of their major objectives. These conclusions were made without providing empirical evidence.

A study by the Australian Bureau of Agricultural and Resource Economics (ABARE) suggested (Jolly et al., 1990, pp. 1–3) that CPS schemes were doing little to offset macroeconomic fluctuations and that any macroeconomic need for the CPS schemes will tend to diminish. The study also suggested a definitive research to study the macroeconomic benefits of CPS.

Guest (1989, p. 2) concluded that price stabilisation schemes have a very important role in strengthening macroeconomic performance and prospects. He also emphasised that further studies should concentrate on evaluating the macroeconomic impacts of CPS. SRI International (1990, p. 218) studied the price stabilisation schemes in PNG and concluded that the macroeconomic significance of the schemes has been declining due to the declining size of the funds and share of tree crop export earnings in the total value of exports.

Fleming (1992) studied the CPS in South Pacific countries, including PNG, and concluded that it is hard to believe that the stabilisation schemes have much effect on macroeconomic stability. According to Schiff and Valdés (1992), the stabilisation of producer price is more beneficial in the case of tradeable products that are important in total net trade (total exports minus total imports), because of their contribution to macroeconomic stability. Opa (1992) reported that one of the main objectives of CPS is to contribute to general economic stability. Gumoi (1993, p. 34) evaluated the price stabilisation schemes in PNG, and concluded that their contribution to macroeconomic stability has diminished over time. Temu (1995, p. 33) expressed the view that the macroeconomic benefits of the stabilisation scheme seem somewhat overrated.

Economists differ in their opinion about the macroeconomic impacts of CPS. In this paper, empirical findings are reported from a macroeconometric simulation study of the impacts of CPS in PNG. The present

study provides empirical evidence to assess the relevance of keeping the price stabilisation policy as an integral part of the macroeconomic policy framework and to decide on the policy options either to continue these schemes or to allow the producers to face the challenges of the market. A macroeconometric model is used to evaluate the impacts of CPS schemes.

3. Overview of the macroeconometric model

A complete description of the macroeconometric model, used to conduct simulation studies, is available in Kannapiran (1998a, b) and a brief description of the model is presented in this section. The model, in part a derivative of the Mundell–Fleming model, is designed in an IS–LM framework. In most developing countries, including PNG, the processes of expectation formation and lagged adjustment are quite different from processes found in the developed world. According to Pesaran (1987), for example, economic agents in developing countries may be prevented from forming rational expectations because of lack of information and expertise. Accordingly, the model of the PNG economy is built around the simplifying assumption that expectations are naive. Under the naive expectation, the observed or past values of variables are used under the assumption that the future value of the variables will be the same as the observed or past values. Realistic formulations of economic model often require inclusion of lagged explanatory variables in order to capture the dynamics of time lag between the causes and effects, because of slow responses (Ramanathan, 1992; Gujarati, 1995). Appropriate lag lengths for all variables of the stochastic equations are determined using model selection criteria of Akaike (AIC), Rice, Shibata and Schwartz (Ramanathan, 1992).

The model consists of six blocks corresponding to the four well-known macroeconomic identities: *national accounts, fiscal, BOP and monetary equilibrium,* and two policy variables: *employment and inflation*. There are seven stochastic equations and eleven identities in the structural model. The model consists of 39 variables, including 5 lagged variables and 18 endogenous variables in 18 equations. The stochastic structural equations and identities and a description of the variables of the model are available in the Appendices A and B. Most time series macroeconomic variables are non-stationary and using non-stationary variables in the model might lead to spurious regressions (Granger and Newbold, 1977; Plosser and Schwert, 1977). The augmented Dickey–Fuller unit root test result reveals that the growth rates of income and employment are stationary at levels and the remaining variables are stationary after fourth-order first differencing (i.e. $\Delta X_t \equiv X_t - X_{t-4}$). Stationary variables are used in the econometric version of the model to eliminate any possible spurious regression. Granger (1981) identified a situation when the regressions among non-stationary variables are not spurious if the linear combination of the variables is stationary and cointegrated. Linear combination of the variables of each function of the model is tested for cointegration using the Johansen trace tests (Johansen and Juselius, 1990) and the results reveal that the variables in the private investment, tree crop export quantity, imports and money demand (and nominal interest) functions are cointegrated. Granger and Weiss (1983) indicated that error correction model (ECM) specification could be used when the linear combinations of variables are cointegrated at levels. All cointegrated equations are specified in an ECM framework using the Engle–Granger two step method (lagged residual of static regression as error correction term).

4. Estimation and evaluation of the model

The model is estimated using the quarterly time-series data for the period 1975-I to 1995-IV (PNG became an Independent State in 1975). The dynamic simultaneous equation model is overidentified and therefore initially it is estimated using two-stage least squares (2SLS). A modified 2SLS-Cochrane–Orcutt procedure (see Pindyck and Rubinfeld, 1991; Ramanathan, 1992) is subsequently used to re-estimate all equations because autocorrelation is found to be present. SHAZAM econometric package is used to estimate the model. The signs of the estimated coefficients are consistent with prior expectations and most coefficients are statistically different from zero at usual levels of significance. The parameter estimates, standard errors and the '*t*' values are furnished in Table 1. Tests of model specification play an important role in the evaluation of econometric models and economic forecasts. Various

Table 1
Parameters estimates, standard error and t-values

Equations	Parameters	Coefficients	Standard error	t-value
Private consumption				DF=61
Constant	α_1	26.7450	5.016	5.33**
Y_t^d	β_1	0.1472	0.0525	2.80**
RR_{t-4}	χ_1	−10.0230	2.705	−3.71**
Private investment				DF=59
Constant	α_2	−2.564	6.721	−0.38
Y_t	β_2	0.0881	0.0233	3.78**
RR_t	χ_2	−2.2588	1.268	−1.78*
KA_{t-3}	δ_2	0.1415	0.038	3.71**
EC_1	ε_2	0.6777	0.1595	−4.25**
Tree crop exports				DF=59
Constant	α_3	0.0345	0.0314	1.09
PI_{t-6}	β_3	0.2957	0.2378	1.24
PS_{t-6}	χ_3	0.0047	0.0028	1.69*
EX_{t-6}	δ_3	−0.1447	0.0297	−0.48
EC_2	ε_3	−0.0089	0.0515	−1.74*
Imports				DF=60
Constant	α_4	12.7680	5.683	2.25*
Y_t^d	β_4	0.1415	0.0395	3.58**
GS_{t-5}	χ_4	0.2558	0.050	5.09**
EC_3	δ_4	−0.3311	0.1096	−3.02**
Money demand				DF=59
Constant	α_5	−9.3752	4.886	−1.92*
M_{t-1}^d	β_5	0.9500	0.0424	22.41**
Y_t	χ_5	0.2617	0.0311	8.41**
NR_t	δ_5	−0.3500	2.170	−0.16
EC_4	ε_5	−1.4034	0.170	−8.24**
Nominal interest rate[a]				DF=59
Constant	γ_0	2.835	0.689	4.11**
M_{t-1}^d	γ_1	0.0020	0.0012	1.76*
M_t^d	γ_2	0.0019	0.0011	−1.64
Y_t	γ_3	−0.0001	0.0005	0.13**
EC_5	γ_4	−1.06	0.1400	−7.58**
Employment rate				DF=61
Constant	α_6	−0.5996	0.3907	−1.54
ER_{t-1}	β_6	0.7829	0.1161	6.75**
YR_{t-2}	χ_6	0.0694	0.0246	2.82**
Inflation rate				DF=59
Constant	α_7	−1.4512	0.32	−4.60**
M_{t-3}^d	β_7	0.0097	0.0019	5.06**
BD_{t-5}	χ_7	0.0042	0.0016	2.58**
EX_t	δ_7	−7.4696	1.530	−4.87**
AXP_{t-3}	ε_7	0.1333	0.0381	3.49**

*Significant at 5%.
**Significant at 1%.
[a]Equation derived by solving money demand equation.

Table 2
Results of diagnostic and evaluation tests[a]

Details	Consumption			Investment			Exports (TXQI)			Imports			Money demand			Employment (%)			Inflation (%)		
Model	AR(4)[1]			ECM^2–AR(4)			ECM–AR(4)			ECM^2–AR(4)			ECM^2–AR(4)			AR(4)			AR(4)		
Goodness of fit	DF			DF			DF			DF			DF			DF			DF		
R^2	1	67	0.56	3	64	0.64	3	64	0.48	2	65	0.61	4	63	0.82	2	65	0.67	4	63	0.63
R^2 (adjusted)			0.55			0.62			0.45			0.59			0.81			0.66			0.61
Test for autocorrelation																					
LM test–Chi-square test: DF=4			1.98			6.72			2.13			3.49			2.31			2.38			7.12
Tests for heteroscedasticity																					
Chi-square test																					
BPG[3] test	2		1.76	4		0.764	4		2.93	3		1.12	4		5.07	2		0.88	4		6.86
Engle's ARCH test	1		0.44			12.831*	1		2.93	1		5.38*	1		0.51	1		0.19	1		3.11
Specification error test (Ramsey Reset) F-test																					
RESET (2)	1	64	7.99*	1	62	0.40	1	62	2.14	1	63	1.88	1	62	0.23	1	64	2.14	1	62	2.57
RESET (3)	2	63	4.04	2	61	0.25	2	61	2.20	2	62	1.56	2	61	0.11	2	63	1.61	2	61	3.51*
RESET (4)	3	62	2.65	3	60	0.18	3	60	1.97	3	61	2.62	3	60	0.08	3	62	1.22	3	60	2.38
Normality test–Chi-square test																					
Jarque–Bera LM test: DF=2			25.43*			0.91			3.37			6.26*			90.41*			0.29			0.18
Structural break-Chow test																					
F-value	3	62	1.75	5	58	0.56	5	58	1.71	4	60	1.32	5	58	0.59	3	62	0.84	5	58	1.22
Predictive accuracy tests																					
Mean absolute error			44.26			702.86			0.254			33.63			40.72			2.73			1.08
Root mean square error			65.74			26.51			0.345			50.95			62.12			3.35			1.43
Theil inequality coefficient U			0.815			0.854			0.864			0.818			0.85			0.90			0.62

*Significant at 5%.

[a]AR(4) — Autoregressive (fourth-order) model; ECM — Error correction model; BPG — Breusch–Pagan–Godfrey test.

tests are conducted to detect heteroscedasticity, autocorrelation, non-normality, other possible forms of model misspecification and to measure the predictive accuracy and goodness-of-fit. Results of these tests are reported in Table 2.

The disturbance terms in all equations, except investment and imports, are homoscedastic, as revealed by the Breusch–Pagan–Godfrey (BPG) and the Engle's autoregressive conditional heteroscedasticity (ARCH) tests (Table 2). The BPG test results suggest that the error terms in the investment and imports equations are homoscedastic, whereas the ARCH test results reveal that the investment and imports equations are heteroscedastic. The BPG test is more powerful but the ARCH test is more appropriate for time series data (Kmenta, 1986). According to Greene (1993), it is rarely possible to be certain about the nature of the heteroscedasticity in a regression analysis. On using generalised least square (GLS to estimate the heteroscedastic models), Greene suggested that the additional variation incorporated by the estimated variance parameters may offset the gains to GLS. A Lagrange multiplier (LM) test (appropriate to test fourth-order serial correlation, that is common with quarterly time series data, in the presence of lagged dependent variables (Ramanathan, 1992; Greene, 1993)) results suggest that the error terms of 2SLS-CORC method estimate are not serially correlated (see Table 2). The Jarque–Bera LM test (see Greene, 1993) results reveal that the residuals in all but three equations (consumption, imports and money demand) are normally distributed (see Table 2). This test is essentially non-constructive and the finding of non-normality does not necessarily suggest what to do next. Further, failure to reject normality does not confirm it and it is only a test of symmetry and mesokurtosis (Greene, 1993). The central limit theorem provides a theoretical assumption of normality of residuals with a few exceptions (Gujarati, 1995).

Chow tests indicate that there is no structural breaks in the sample period between the pre- and post-mineral boom period (1979–1986 and 1987–1995). The RESET test (see Table 2) suggests that, with the possible exception of the consumption and inflation equations, no equation suffer from omitted variables or incorrect functional form.

Finally, the usual (adjusted) coefficient of determination (R^2 and adjusted R^2) are used to measure the goodness-of-fit of the estimated model, and the three common measures of predictive accuracy (root mean square error (RMSE), mean absolute error (MAE) and Theil's inequality coefficient (U)) used to evaluate its predictive performance. These results are satisfactory and are reported in Table 2.

5. Simulation studies

A simulation model, used in the present study, is formulated by using the model estimates. A dynamic causal simulation approach is adopted in the present study. The parameters estimated by 2SLS-CORC methods are substituted in the model and solved for each endogenous variable to obtain the reduced (implied reduced form) [1] form equations (Pindyck and Rubinfeld, 1991; Ramanathan, 1992). The reduced form equations are useful to conduct short-term and static simulations; but they are not useful to determine the dynamic or long-term impacts of changes in endogenous variables (Kmenta, 1986; Pindyck and Rubinfeld, 1991). The purpose of the present simulation is to study the long-term impacts of price stabilisation (CPS) that involves the dynamic long-term impacts and therefore, fundamental dynamic equations (FDE) must be used. The reduced form equations are reformulated so that each equation contains only one endogenous variable, whether current or lagged (i.e. FDE). The simulation model comprises all of these FDEs along with other equations where the estimated values of endogenous variables replaced the current and lagged values of LHS variables on the RHS by recursive substitution. An appropriate shazam program, incorporating the simulation model, is developed specifically to run various simulations.

Using the simulation model, simulation studies are conducted to assess the macroeconomic impacts of CPS. The contribution by CPS to export tax is negligible and the stabilisation fund is self-financing and, therefore, the CPS has not affected the fiscal budget in PNG. The CPS has no direct effect on the incomes

[1] Ramanathan (1992, pp. 547–548) termed the reduced form parameters, obtained by using the 2SLS estimates, as 'implied reduced form estimates'. He also indicated that the multipliers of endogenous variables with respect to the exogenous variables (policy variables) obtained by using the implied reduced form estimates are more efficient.

of tree crop exporters (when the bounties and levies are fully passed on to the producers) or total export income (X) (or national income). The CPS (buffer) funds (K 175 million in 1987) in domestic currency are deposited with the Bank of PNG (BPNG — Central Bank) or with commercial banks and therefore, it is partly sterilised (to the extent that it is deposited with the BPNG). In most years, part of the CPS funds are deposited with commercial banks and are available for lending by banks (that is, not sterilised). The impacts on monetary stability may be limited when the CPS funds are not sterilised.

In reality, price stabilisation leads to a transfer of funds from one sector (producers) to others when funds are not fully sterilised. In some years, the CPS funds were used to finance other activities. It is, therefore, hard to simulate the macroeconomic impacts of price stabilisation under a different scenario of sterilisation of CPS funds. Further, as the CPS funds are operated in domestic currency and not maintained in foreign currency, the direct effect of stabilisation on BOP is almost negligible. The CPS, however, affects the price (net of bounties and levies) paid to the ultimate producers that might have affected the income of the producers and the export quantity produced (production response to price). Through the production response and the impact on the producers' income, the CPS affects all other macroeconomic variables. The effectiveness of CPS in stabilising the macroeconomy is evaluated under the options *with* CPS (WCPS) and *without* CPS (WOCPS).

In practice, it is usual that there is *partial sterilisation of CPS funds* where funds are deposited with both the BPNG and the commercial banks. These (observed) values are used for the base or factual run (WCPS) (under the prevailing condition of 'with CPS' and at the current level of sterilisation). In the counterfactual analysis, WOCPS (at the prevailing sterilisation rate) shock is introduced and the simulated values of various macroeconomic variables are generated. The WOCPS shock affects the price support variable (PS=price subsidy plus CPS) and therefore, the shock is introduced by changing the value of the exogenous variable 'PS' under the tree crop export quantity equation.

The shock is continuous and maintained throughout the study period. The shocks are introduced in 1977 and the estimation is carried-out from 1979–1995. The lagged impacts (say for example of PI_{t-6}), therefore, will already be there when the simulation study commences. The shock-adjusted value of the tree crop export income is introduced into the simulation model. The impacts of the introduced shock are expected to have been different in the mineral boom period (1987–1995) because of the declining share of tree crop exports in GDP. The presentation, therefore, focuses on the impacts in each of two reasonably distinct time periods: the pre-mineral boom period from 1979 to 1986, and the post-mineral boom period from 1987 to 1995.

Macroeconomic variables are generated under 'with CPS' (factual or base run) and 'without CPS' (counter-factual or simulated run) and compared. The average percentage changes in the relevant macroeconomic variables and their variances under the factual and the counterfactual runs are estimated and furnished in Table 3 separately for pre- (1979–1986) and post-mineral boom (1987–1995) periods. Finally, the variances of the variables generated in the factual and counterfactual runs are estimated to evaluate the impacts of CPS on macroeconomic stability. An F-test is used to test whether the variances of estimated values of variables under factual and counterfactual runs are the same. The F-test details are H_0: $s_1^2 = s_2^2$ and H_1: $s_1^2 \neq s_2^2$, where s_1^2 is the variance of the factual run and s_2^2 is the variance of the counterfactual run. If the estimated F-value is less than the table value of F then the null hypothesis (H_0), that the two variances are equal, cannot be rejected. F-test values for testing the equality of variances of base (with CPS) and simulated (without CPS) value of the variables are also furnished in Table 3and also in Fig. 1.

6. Results and discussion

A summary of the findings of the study is reported separately for the pre- and post-mineral boom periods (Table 3 and Fig. 1). The results of the present study must be interpreted in conjunction with the circumstance explained here. During the pre-mineral boom period, the levies were mainly collected and the fund balance was around US$ 170 million. In contrast, during the post-mineral boom period, payment of bounties dominated the operation that led to the depletion of the CPS funds in 1992. Further, the results must

Table 3
Average percentage changes in macroeconomic variables with and without CPS and tests of similar variances of base-level and simulated variables, 1980–1995[a]

Macroeconomic variables	Percentage change	Variances of variables		*F*-value
		With CPS	Without CPS	
A. *Pre-mineral boom period 1980–1986*				
Private consumption	−0.35	795	733	0.05
Investment	−1.24	206	190	0.05
Tree crop exports	−0.34	755	737	0.01
Imports	−0.58	164	194	0.19
Money demand	−1.78	3728	2967	0.36
Interest rate	0.0001	2.23	2.23	0.00
Employment	−0.11	6.12	3.62	1.87
Inflation	−0.01	0.85	0.77	0.07
BOP	1.11	1641	1574	0.01
GDP	−2.70	6494	5256	0.35
B. *Post-mineral boom period 1987–1995*				
Private consumption	−0.62	1228	1267	0.01
Investment	−2.02	757	776	0.01
Tree crop exports	−0.28	8114	2241	0.01
Imports	−1.32	1615	1576	0.01
Money demand	−2.16	26886	25587	0.02
Interest rate	−0.0001	4.20	4.19	0.00
Employment rate	−0.10	8.26	8.61	0.02
Inflation rate	−0.01	4.02	3.70	0.06
BOP	8.14	11993	11980	0.00
GDP	−1.99	31012	31997	0.01

[a] *F*-test values refer to the probability that the variances of the factual and counterfactual datasets are the same; degrees of freedom: DF1 and DF2: 1 and 59; ** and * significant at 1 and 5% (others not significant).

be reviewed under different policy scenario. The impacts must be different under the scenario of 'with' and 'without' sterilisation of the CPS funds. However, the sterilisation impacts are diluted or offset by the release of the sterilised funds as bounties when the prices are low, and therefore the net effect is negligible. The stabilisation funds were occasionally utilised to finance the other budgetary activities and, therefore, the impact may not be clear. An attempt to trace those dynamics such as the impacts of disbursement of the sterilised CPS fund as bounties and the diversion of the sterilised funds by the government on some occasions is not successful due to a lack of data. In addition, under the without CPS scenario, the possible impacts on other exogenous variables like the financial market, taxation etc. are untraceable (data limitations). An evaluation follows of the results reported in Table 3.

6.1. Private consumption and Investment

Without the CPS, private consumption and investment decline by 0.35 and 1.24%, respectively, during the pre-mineral boom period. During the post-mineral boom period, consumption and investment decrease by 0.62 and 2.02%, respectively. This finding suggests that the consumption and investment might have decreased without CPS. CPS has increased impacts after the mineral boom in spite of the diversification in the rural sector and the development of the service sector. As indicated earlier, payment of bounties dominated the CPS fund operation during the post-boom period and therefore CPS might have greater influence in the post-boom period. Love (1989) reported that export income instability affects investment.

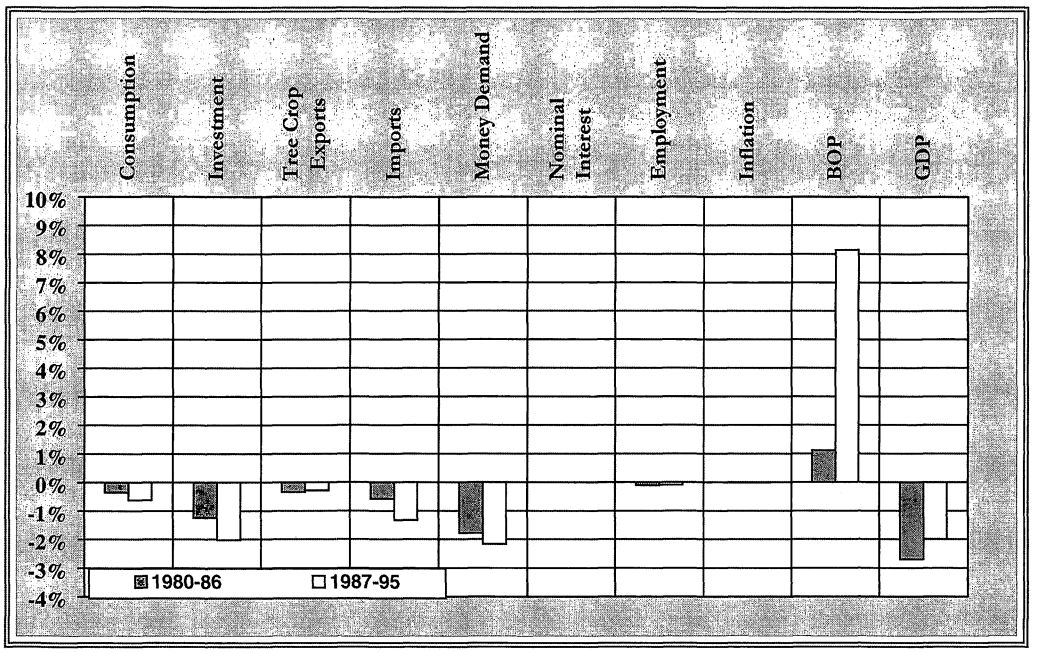

Fig. 1. Percentage changes in the macroeconomic variables under without CPS scenario over the base level (with CPS).

6.2. *Tree crop export income*

Tree crop export income increases with CPS and declines without CPS. Without the CPS, tree crop export income declines by 0.34 and 0.28% during the pre- and post-mineral boom periods, respectively. CPS continues to affect tree crop export income at a reduced level after the mineral boom. This finding suggests that the role of CPS in increasing the tree crop export income is negligible and declining during the post-mineral boom period. The finding also reveals that the CPS leads to higher private consumption (see Section 6.1) than production responses.

6.3. *Imports*

Imports decrease by 0.58 and 1.32% during the pre- and post-mineral boom periods, respectively, without CPS. The decrease in imports corresponds to a decline in tree crop exports; but the imports decrease at a higher proportion than exports. As discussed previously, the CPS schemes paid out mainly bounties during the post-mineral boom period, as against collection of levies in the pre-mineral boom period. Further, in the post-mineral boom period there is a higher proportion of imported components in household consumption and farm production. These are the probable reasons for the increased impact during the post-mineral boom period.

6.4. *Money demand and Interest rate*

Money demand decreases by 1.78 and 2.16% under the without CPS scenario during the pre- and post-mineral boom periods, respectively. It is obvious that CPS induces monetary expansion and, therefore, it is doubtful that the CPS plays an important role in monetary stability as presumed by Guest (1989). Again, a higher level of continuous payments of bounties during post-mineral boom period must be responsible for the higher response during that period. The nominal interest rate responds positively and negatively (to a negligible extent) to the 'without CPS' conditions during the pre- and post-mineral boom periods, respectively.

6.5. Employment and Inflation rate

Without CPS, the employment rate declines by about 0.10% and the inflation rate declines by a negligible amount (0.01%), during the pre- and post-mineral boom periods. The reliable published data on employment rate is needed to justify the argument that CPS schemes seem to have influenced the employment rate favourably. The employment data on the informal sector and non-tree crop sector, that includes subsistence sector, are either inconsistent or omitted.

6.6. The BOP position

The BOP position improves without CPS by 1.1 and 8.1%, respectively, under pre- and post-mineral boom periods. A relatively higher decrease in imports than exports associated with the 'without CPS' scenario (Section 6.3) must be the reason for a favourable improvement in the BOP. The higher proportion of changes in the BOP during post-mineral boom period corresponds with the higher proportion of changes in the BOP associated with tree crop export instability during the same period (see Kannapiran, 1998b). This finding suggests the possible deterioration in the BOP caused by CPS. When the commodity prices are low, the export earning and exchange reserves must be low. Coinciding with low prices, the CPS schemes provide bounties that increase the private spending and imports (see Section 6.3) leading to a greater strain on exchange reserve. This must be one of the reasons for the adverse impact of CPS schemes on the BOP position.

6.7. GDP position

GDP declines by 2.7 and 1.9% without CPS during the pre- and post-mineral boom periods, respectively. After the mineral boom, the impact declines substantially. Again, this is most likely due to the diversification of the economy that might have reduced the relative importance of the tree crop exports and the declining share of tree crop exports. Although the contribution of CPS to the GDP declines, it continues to be substantial. However, if the CPS is not self-financing (it was self-financing until 1989) and needs budgetary support, then the impact is likely be different.

6.8. Macroeconomic stability

The F-values, used to compare the variances of variables generated under the factual (with CPS) and counterfactual (without CPS) runs, in all cases suggest that the null hypothesis (that the variances are the same) cannot be rejected (see Table 3). The results suggest the failure of CPS schemes to stabilise the macroeconomy. This finding confirms the conclusions by Temu (1995) and ABARE (Jolly et al., 1990), but differs from the findings of Guest (1989). Sterilisation of CPS funds might possibly have reduced some instability. However, the negligible size of the sterilised funds (as a proportion of the money stock and GDP), and the utilisation or disbursement of the sterilised funds for payment of bounties or other purposes, reduce the importance of the CPS.

In summary, the impact of CPS on the monetary sector, external balance (BOP) and the income (GDP) are important from the policy perspective. These impacts are explained using the IS–LM diagram (Fig. 2). The BOP equilibrium (BOP=0) function (BOP=$X-Z+$KA; where KA is the capital account, X the exports and Z the imports) is introduced into the IS–LM diagram. KA (capital mobility) is an exogenous variable and not interest elastic in PNG and therefore the BOP curve is vertical. At a higher income level, the imports exceeds exports and therefore the area on the right side of the BOP function (equilibrium) is a BOP deficit area and the area on the left side is a BOP surplus area (exports exceeds imports) (see Dernburg, 1985, p. 358). For over a couple of decades (1975–1990), PNG followed an accommodating monetary policy and controlled the money supply (on several occasions controlled the interest rate) in order to prevent interest rates from increasing. The LM curve is, therefore, horizontal because of the monetary policy interventions (see Dornbusch et al., 1998, p. 379).

According to the present findings, the CPS increases the tree crop exports and the income (Y). The income elasticity of money demand is 0.26 (see Table 1) and therefore, the increased income is accompanied by an increased demand for money. Under the accommodating monetary policy, the monetary authorities use various policy instruments to increase the money supply that leads to further monetary expansion (see Fig. 2). The increased income (disposable income elasticity of

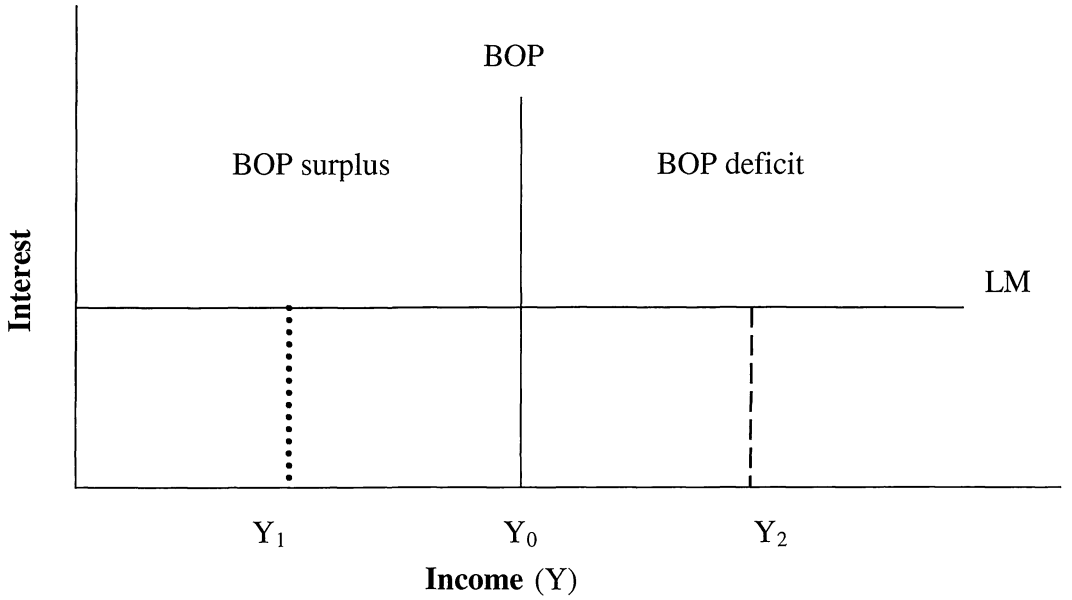

Fig. 2. Impacts of CPS on the GDP, money demand and the BOP.

imports is 0.14) and monetary expansion caused the imports to exceed the exports (see Section 6.3) and thereby leading to BOP deficits. The increased imports (leakage) reduce the income but that effect is off-set by a combined effects of increased consumption and investment caused by a higher proportion of the disposable income elasticity of the private consumption (0.15) and income elasticity of the private investment (0.09). Under the without CPS scenario, the response was in the reverse direction and therefore there is BOP surplus situation. The IMF and World Bank prescription of reducing domestic demand to manage the BOP problem appears to be appropriate in an open economy with an accommodating monetary policy.

7. Conclusions

A macroeconometric policy simulation study is undertaken, using a macroeconometric model, to assess the impacts of CPS policy in PNG. The findings suggest that the macroeconomic impacts of CPS are almost negligible. The impact of CPS on private consumption and investment is insignificant (less than 2%). There is negligible impact on the rate of nominal interest, employment and inflation. CPS has failed to reduce the instability of all the macroeconomic variables studied and, surprisingly, it adversely affected the external balance (BOP) and the monetary stability. The findings suggest that the price stabilisation policies have no favourable contribution to the macroeconomic management. Obviously, there is no valid reason for maintaining price stabilisation schemes for macroeconomic stabilisation purposes.

A preferred policy approach would be to assist producers to meet the challenges of the commodity markets and manage the price risk by themselves. There are three main policy options: (1) Technical Change: By providing appropriate research and extension services to help producers to maintain a diversified income base and to increase productivity through gains in technical efficiency and technological progress; (2) Rural Financial Services: Promoting rural saving facilities to enable rural producers to even out their cash flow over time according to their own needs and circumstances; and (3) Futures Trading: Assisting the producers to hedge against future falls in the prices they receive for their commodities.

Further, if CPS schemes were to be re-introduced then two important issues must be addressed. First,

CPS must be through self-financing schemes that are managed by the tree crop export marketing corporations without any government intervention. Second, to minimise the adverse impact of CPS on the BOP, the stabilisation fund must be kept in foreign currency.

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Appendix A. Structure of the macroeconometric model

1. All variables are in real terms except nominal interest.
2. EC refers to error correction terms and 'Δ_4' stands for fourth-order first difference.

A.1. Behavioural equations

$$\Delta_4 \mathrm{CP}_t = \alpha_1 + \beta_1 \Delta_4 Y_t^{\mathrm{d}} - \chi_1 \Delta_4 \mathrm{RR}_{t-4} + u_{1t} \quad (1)$$

$$\Delta_4 \mathrm{IP}_t = \alpha_2 + \beta_2 \Delta_4 Y_t - \chi_2 \Delta_4 \mathrm{RR}_t + \delta_2 \Delta_4 \mathrm{KA}_{t-3} + \varepsilon_2 \mathrm{EC}_1 + u_{2t} \quad (2)$$

$$\Delta_4 \mathrm{TXQI}_t = \alpha_3 + \beta_3 \Delta_4 \mathrm{PI}_{t-6} + \chi_3 \Delta_4 \mathrm{PS}_{t-6} - \delta_3 \mathrm{EX}_{t-6} + \varepsilon_3 \mathrm{EC}_2 + u_{3t} \quad (3)$$

$$\Delta_4 Z_t = \alpha_4 + \beta_4 Y_t^{\mathrm{d}} + \chi_4 \Delta_4 \mathrm{GS}_{t-5} + \delta_4 \mathrm{EC}_3 + u_{4t} \quad (4)$$

$$\Delta_4 M_t^{\mathrm{d}} = \alpha_5 + \beta_5 \Delta_4 M_{t-1}^{\mathrm{d}} + \chi_5 \Delta_4 Y_t - \delta_5 \Delta_4 \mathrm{NR}_t + \varepsilon_5 \mathrm{EC}_4 + u_{5t} \quad (5)$$

$$\mathrm{ER}_t = \alpha_6 + \beta_6 \mathrm{ER}_{t-1} + \chi_6 \mathrm{YR}_{t-2} + u_{6t} \quad (6)$$

$$\Delta_4 \mathrm{INF}_t = \alpha_7 + \beta_7 \Delta_4 M_{t-3}^{\mathrm{d}} + \chi_7 \Delta_4 \mathrm{BD}_{t-5} - \delta_7 \Delta_4 \mathrm{EX}_t + \varepsilon_7 \Delta_4 \mathrm{AXP}_{t-3} + u_{7t} \quad (7)$$

A.2. Identities

$$Y_t = \mathrm{CG}_t + \mathrm{CP}_t + \mathrm{IG}_t + \mathrm{IP}_t + X_t - Z_t \quad (8)$$

$$Y_t^{\mathrm{d}} = Y_t - \mathrm{TAX}_t + \mathrm{TRP}_t \quad (9)$$

$$\mathrm{RR}_t = \mathrm{NR}_t - \mathrm{INF}_t \quad (10)$$

$$X_t = \mathrm{TX}_t + \mathrm{OX}_t \quad (11)$$

$$\mathrm{TX}_t = \mathrm{TXQI}_t \times \mathrm{PI}_t \times B \quad (12)$$

$$M_t^{\mathrm{d}} = M_t^{\mathrm{s}} \quad (13)$$

$$M_t^{\mathrm{s}} = \mathrm{NFA}_t + \mathrm{DC}_t \quad (14)$$

$$\mathrm{NFA}_t = \mathrm{NFR}_t + \mathrm{BOP}_t \quad (15)$$

$$\mathrm{BOP}_t = \mathrm{CA}_t + \mathrm{KA}_t \quad (16)$$

$$\mathrm{CA}_t = X_t - Z_t + \mathrm{NTR}_t \quad (17)$$

$$\mathrm{YR}_t = \frac{Y_t - Y_{t-4}}{Y_{t-4}} \times 100 \quad (18)$$

Appendix B. Description and classification of variables

B.1. Endogenous variables

BOP	balance of payments
CA	current account
CP	private consumption
ER	employment growth rate (1989=100)
INF	rate of inflation (1977=100)
IP	private investment
M^{d}	real money demand
M^{s}	real money supply
NFA	net foreign assets
NR	nominal interest rate
RR	teal interest rate
TX	tree crop export income
TXQI	tree crop export quantity index
X	total exports

Y	gross domestic product (GDP)
Y^d	personal disposable income
YR	rate of growth of GDP (Y)
Z	imports of goods and services

B.2. Exogenous variables

AXP	export price index of major trading partner (Australia in the case of PNG)
B	(tree crop export income in 1979-I)/100
BD	budget deficit
CG	government consumption
DC	domestic credit (private and public)
EX	real exchange rate (US$ per Kina)
GS	government spending (IG+CG)
IG	government investment
KA	capital account
NFR	net foreign assets reserve
NTR	net transfers by private and public sector (includes invisible transfer)
OX	other export income
PI	tree crop export price index (US$)
PS	price stabilisation and support
TAX	taxation revenue
TRG	net public sector transfer (overseas)
TRP	net private sector transfer (overseas)

Note: All lagged variables (not listed here) are pre-determined or exogenous.

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