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Macroeconomic impacts of export commodity price subsidy in Papua New Guinea

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A macroeconometric simulation study is undertaken to evaluate the impacts of a price subsidy for tree crops in Papua New Guinea (PNG). The price subsidy had favourable impacts on tree crop export income, aggregate demand, private consumption, and investment and employment. It increased imports, the budget deficit, and the demand for money and adversely affected the fiscal balance, inflation and interest rates, the BOP position and macroeconomic stability. The price subsidy contributed favourably to internal balance but adversely affected external balance. It worked against many of the policy objectives and made macroeconomic management difficult. With the introduction of the price subsidy, the government violated the commitments made under the Uruguay Round Agreement on Agriculture and PNG's Structural Adjustment Program.

1. Introduction

The Uruguay Round Agreement on Agriculture (URAA) committed member countries to reducing the level of export subsidies for agricultural commodities over the period 1995 to 2000 (Leetmaa and Ackerman 1999). The structural adjustment program (SAP), undertaken by Papua New Guinea (PNG), with assistance from the World Bank and IMF, places emphasis on making domestic prices closer to international prices. The transmission of world price signals to domestic markets allows a more efficient allocation of resources not only in the commodity sector but also in the overall economy (Baffes and Varangis 1997). By giving wrong market signals, price subsidies adversely affect the efficiency of resource allocation and macroeconomic stability. PNG made commitments under the URAA and SAP (1989–92) to eliminate subsidies. Contrary to its commitments, the government of PNG introduced the tree crop export commodity price subsidy (Agricultural Guaranteed Price Support — AGPS) in November 1992.

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A number of studies have found that subsidies have harmful effects in developing countries (see Baffes and Varangis 1997; Leetmaa and Ackerman 1999; Gumoi 1994 and World Bank 1994). The present study is undertaken to evaluate the macroeconomic impacts of the tree crop export price support in PNG and the findings are reported in this article. First, a brief introduction to the economy of PNG and AGPS is presented. The remainder of this article is organised according to the three important stages of the present research:

1. developing a macroeconomic model and evaluating the model;
2. developing a macroeconometric simulation model using the model estimates and conducting simulation studies; and
3. measuring the macroeconomic impacts, discussing the results and drawing conclusions.

The findings of the study will be of interest to policy planners of PNG, to multilateral and bilateral donors of PNG as well as to other developing economies in Asia, Africa and Latin America which are facing similar problems in managing the commodity price policy. The analysis in this study, being macroeconomic in focus, does not address the microeconomic consequences of the export price subsidy.

2. An overview of the PNG economy

PNG is a lower middle-income developing country with a small, open economy. Its per capita gross national product (GNP) was equivalent to US$1160 in 1996 (Asian Development Bank (ADB) 1997) and the nominal gross domestic product (GDP) was K7161 million[1] in 1998. On the fiscal operations, the total internal revenue was K2076 million and the total expenditure was K2165 million, with a budget deficit of K89 million in 1998 as against a surplus of K15 million in 1997. In the fiscal years 1995 to 1997, the budget was approximately balanced (Department of Treasury and Corporate Affairs (DTCA) 1998). One of the policy objectives of the PNG government has been to achieve macroeconomic stability (ADB 1997).

During the period from 1975 to 1993, inflation was relatively low and external and internal balances were well managed, except for a short-term shock following the sudden closure of the Bougainville copper mine in 1989. PNG had followed a hard currency policy from 1975 until September 1994. The kina was devalued by 10 per cent in 1990 and again by 12 per cent in September 1994. The fiscal and the balance of payments (BOP) crisis (a BOP

[1] K — PNG currency Kina and one K was approximately equivalent to US$0.35 in November 1999.

deficit of K168 million) in 1994, seriously affected the macroeconomic stability but the situation was well handled because of the implementation of SAP. A floating exchange rate regime[2] was introduced from October 1994 as one of the major components of SAP. After the economic reforms, external economic balance reached a comfortable position with a surplus of K244 million in 1995 and foreign reserves of K432 million in December 1996. During the transition period from 1994 to 1996 (after the 1994 devaluation and floating of the currency), inflation increased by more than 30 per cent, employment opportunities and the growth of national income almost stagnated, and the delivery of services was badly affected. A slow economic recovery nevertheless ensued, with growth rate in real GDP reaching 3.6 per cent in 1996 compared with a negative 2.9 per cent in 1995. However, instability of the exchange rate has been a major threat to macroeconomic stability.

3. Agricultural price support in PNG

Agriculture remains the dominant economic activity in PNG. It provides income, employment and livelihood for some 85 per cent of the population and contributes 26 per cent of GDP and over one-third of export income (World Bank 1997). The major tree crop commodities (coffee, coconut (copra and coconut oil), cocoa and palm oil) contributed K538 million (equivalent to the pre-devaluation value of K360 million) to export earnings during 1996, which was 95 per cent of agricultural exports and 16 per cent of total exports. Development policy for the tree crop industry includes commodity price stabilisation (CPS), a self-financed buffer fund scheme operated under a bounty-levy system. CPS schemes were an integral part of the macroeconomic policy framework. With a continuous decline in commodity prices during the 1980s, CPS funds were almost exhausted in 1990. The PNG government introduced a price support in 1990 (approved in mid-1989) as an interim measure during a period of very low world commodity prices. Subsequently, the government introduced the tree crop export commodity price subsidy (AGPS) in November 1992. The AGPS scheme distributed price subsidy for major tree crop exports when market prices were below the guaranteed prices.[3] It remained in force until 31 October

[2] When PNG had a hard currency policy (1975 to 1994III) the Kina was pegged to a basket of currencies and the exchange rate was trade-weighted (with five major trading partners). Very limited level of exchange control was in existence. The real exchange rate in US$/K, estimated by adjusting for inflation differentials, is used in the present study.

[3] The guaranteed prices under the AGPS were: Coffee K2300/t f.o.b., Cocoa K1300/t delivered-in-store (d.i.s.), Copra K250/t main depot (smoked) and Palm oil K26/t fresh fruit bunch (f.f.b.) (smallholders only).

1997. Budgetary support for the AGPS scheme was around K261 million (around K44 million per year — about 1 per cent of GDP) over the duration of its operation from 1990 to 1997. After the devaluation and the floating of Kina (October 1994), the value of Kina depreciated from K1.05 per US$ in 1994 (September) to K1.5 per US$ in 1997. The depreciation of Kina, coupled with some increase in commodity prices, led to a substantial increase in the Kina value of f.o.b. prices. This brought the market prices closer to the guaranteed prices and, therefore, the level of subsidy in 1995 was negligible and there was no subsidy in 1996–97.

The AGPS was under constant criticism from several economists. A report by the World Bank (1994) indicated that the AGPS scheme appeared to be operating more as an income transfer device than as a stimulus to cost-cutting innovation or rural investment. It also indicated that the scheme encouraged producers in certain areas to shift out of potentially more efficient activities and that subsidies were permitting inefficient large-holders to continue operating. In this respect, the AGPS retarded growth by blunting producers' response to world market forces (prices). Another report by the World Bank (1995a) raised doubts about the positive contribution and the financial sustainability of the AGPS. An action plan prepared by the World Bank (1997, p. vi) suggested that the AGPS should be terminated by October 1997.

The government of PNG tasked the Commodity Working Group to evaluate the AGPS scheme. Several studies were undertaken, as part of a research project funded by the Australian Centre for International Agricultural Research (ACIAR), to study the economic efficiency of tree crop exports and macroeconomic impacts of the AGPS and CPS schemes in PNG. The first phase of the project involved a microeconomic analysis that evaluated the economic efficiency of tree crops, in terms of international competitiveness and comparative advantage under the different scenario of prices and exchange rates. Results of the microeconomic analysis are available in Kannapiran (1998) and Kannapiran and Fleming (1999). According to those studies, PNG has been an efficient producer of coffee and palm oil and the economic efficiency of copra and cocoa production was restored and improved after the devaluation. Coffee and oil palm industries were able to manage commodity price fluctuations of 30 per cent, with or without the devaluation of the kina. After the devaluation, the cocoa and copra industries improved their capacity to manage commodity price fluctuations and all tree crop industries improved their financial and economic rate of return to a level above the opportunity cost of capital. The competitiveness and comparative advantage of the tree crops also improved (see Kannapiran 1998 and Kannapiran and Fleming 1999). These findings support the views of the critics of the hard currency policy (see, for example,

ADB 1993; World Bank 1995a) who blamed the exchange rate for the declining international competitiveness and poor performance in the tree crops sub-sector in the period 1989 to 1994. As a second phase of the ACIAR project, the present study is undertaken to assess macroeconomic impacts of the AGPS and the results are presented and discussed.

4. Macroeconometric model of PNG

The economy of PNG is modelled in an equilibrium condition under an IS-LM framework and is used in the present study. A complete description, including the theoretical foundation and specification details, of the model (both macroeconomic and macroeconometric versions) is available in Kannapiran (1998) and a brief introduction to the model is presented here. Model specification of a developing economy requires the recognition of the special nature of the formation of expectations, lag structure (lagged responses) and possible structural breaks. According to Pesaran (1987), economic agents in developing countries may be prevented from forming rational expectations (RE) because of a lack of information and expertise (see also Klein *et al.* 1999). Accordingly, the present model is built upon the assumption that expectations are naïve. Realistic formulations of economic relations often require inclusion of lagged explanatory variables and economic theory cannot be expected to yield strong insights about lag structure (Hudson and Dymiotou-Jensen 1989; Gujarati 1995). Greene (1997) suggested a set of model selection tests to determine an appropriate lag structure. However, he cautioned that the economic theory must determine which variables belong to the model. Initially, a lag length of '*n*' periods is included in the specification and appropriate lag lengths are subsequently determined (and included in the final version of the model) using model selection criteria. There are chances of structural changes in the economy caused by the mineral boom, the SAP, the devaluation of the currency and other macroeconomic policy changes. These structural changes or breaks are tested (Chow test) to verify the parameter stability of the model.

The model is built around the four well-known macroeconomic identities — *national income*, *fiscal identity*, *monetary equilibrium* and *BOP identity* — and two policy equations, *inflation* and *employment*. These are the minimum requirements of a model to ensure consistency in macroeconomic analysis (Easterly 1989). The structure of the macroeconometric model (equations 1–18) and a description and classification (both exogenous and endogenous) of the variables are available in the Appendix.

The national income identity ($Y = C + I + X - Z$) is the main building block of the model (equation 1). Consumption (C) and investment (I) are

further classified as endogenous private consumption (CP) and private investment (IP) and exogenous public consumption (CG) and public investment (IG) (Bier 1992; World Bank 1995b). CP is specified (equation 2) as a function of real personal disposal income (Y^d) and real interest rate (RR). Y^d is an identity (equation 3) estimated as Y plus (minus in the case of net transfer out of the country) net private sector overseas transfer (TRP), minus taxes paid (TAX), all in real terms (Dornbusch and Fischer 1998; Haque *et al.* 1990). RR is defined (equation 4) as the nominal interest rate (NR) minus the actual rate of inflation (INF) (Dornbusch and Fischer 1998). IP is specified (equation 5) as correlated to real income and lagged capital account balance (KA) and lagged real interest rate (RR) (see Dornbusch and Fischer 1998; Haque *et al.* 1990; Chou and Lin 1994).

Exports (X) are (equation 6) the total of tree crop exports (endogenous variable TX) and other exports (exogenous variable OX). TX, an identity (equation 7), is the product of the export price index (PI) and the quantity index of tree crop exports ($TXQI$). The product of two indexes times the base-year (1979I = 100) actual quantity of tree crop exports (B) gives actual quantity of exports (factor reversal). $TXQI$, an endogenous variable, is a function (equation 8) of price in US$ (expressed as a price index), the price support and price stabilisation (PS) and the real exchange rate in US$/K ($EX$). The exchange rate is considered as an exogenous policy-driven variable because of the fixed exchange rate regime (for the time series data period (1975–I to 1994–III) of the present study.

Real imports are specified (equation 9) as positively related to Y^d and government spending (GS) (where $GS = CG + IG$) (see Aghevli and Sassanpour 1982; Lopez and Thomas 1990). Under the fixed exchange regime, the exchange rate could not play an important role and therefore is not included in the import demand function. GS is an exogenous variable and Y^d is already specified as an endogenous variable.

The fiscal identity specifies the budget deficit (BD), or surplus, as government expenditure ($CG + IG$) plus net overseas transfers by the public sector (TRG) minus taxes (TAX), all expressed in real terms. As the fiscal identity consists of policy-driven exogenous variables,[4] it can be estimated by non-parametric method (see Kannapiran 1998).

Money market equilibrium is an identity (equation 10) that equates the

[4] CG, IG and TRG are exogenous policy variables and determined by fiscal policies. TAX is jointly determined by the taxation policy and the endogenous variable national income and therefore it is made of both exogenous and endogenous component. The endogenous component of TAX could not be tracked because of data limitation (distribution of income among various tax rate groups) and in order to keep the model simple and parsimonious.

demand for real money with the supply of real money. Demand for money (M^d) is specified (equation 11) as a function of Y, nominal interest (NR) and lagged money demand (Arize 1994; Haque *et al.* 1990). NR is determined as an endogenous variable by solving equation 11 for NR (see Ramanathan 1992, p. 544). The supply of money (equation 12) is the sum of net foreign assets (NFA) and domestic credit (DC) in accordance with the macroeconomic accounting by the Bank of PNG (BPNG 1995; see also Haque *et al.* 1990). DC is an exogenous variable determined by the lending and other policies of banks, and monetary and fiscal policies of the government (Haque *et al.* 1990). NFA is an endogenous variable determined (equation 13) by the NFA reserve (exogenous) and the BOP (endogenous). The overall BOP is specified (equation 14) as the sum of current account (CA) and capital account (KA, an exogenous variable) balances. CA is specified as an identity (equation 15) consisting of exports minus imports plus net transfers (NTR). NTR, an exogenous variable, includes the net invisible transfers together with private and public sector net transfers.

The seasonal growth rate of employment is expressed (equation 16) as a function of lagged employment growth rate (ER_{t-1}) and the lagged seasonal growth rate of Y (YR) (see Okun 1974; Hall and Henry 1988). YR is an identity (equation 17) of the seasonal growth rate of Y. Inflation is specified as a function (equation 18) of M^d, the budget deficit (BD) (see Harberger 1980; Sowa 1994), the import price index or alternatively export price index (AXP) of major trading partners and the real exchange rate (EX). As Australia is the major source of imports into PNG, the Australian export price index is used as a proxy for PNG's import price index.

There are seven stochastic equations and eleven identities in the macroeconometric model. The model consists of 39 variables, including 5 lagged variables. Altogether, there are 18 endogenous variables in 18 equations in the model (see the Appendix).

5. Data processing and econometric transformation

Quarterly time series data for the period 1975–I to 1995–IV were collected from the International Financial Statistics of the IMF, the *Quarterly Economic Bulletin* of the Bank of PNG and the National Statistical Office of PNG. Most time series of macroeconomic variables are non-stationary but their first or second difference will usually be stationary (Griffiths *et al.* 1993; Ramanathan 1992). Using non-stationary variables in a model might lead to spurious regressions (Granger and Newbold 1977; Plosser and Schwert 1977). In quarterly data, the seasonal difference ($X_t - X_{t-4}$) of a unit root process may be stationary (Enders 1995). All variables are tested at levels and at fourth-order first difference ($X_t - X_{t-4}$) for stationarity using the

augmented Dickey-Fuller (ADF) test. DeJong *et al.* (1992) concluded that the ADF test procedure is reasonably well behaved. The ADF test result suggests that growth rates of income and employment are stationary at levels and the remaining variables are stationary after fourth-order first differencing (i.e. $\Delta X_t \equiv X_t - X_{t-4}$). All the non-stationary variables are differenced to make them stationary. As discussed in section 4, the appropriate lag structures for all stochastic equations are identified and incorporated.

5.1 Cointegration and error correction model (ECM)

Long-run relationships among variables are lost during the process of differencing nonstationary variables to make them stationary. According to Granger (1981), regressions among nonstationary variables are not spurious if they are cointegrated and an ECM specification could be used when linear combinations of variables are cointegrated at levels (Granger and Weiss 1983). Variables in the private investment, tree crop export quantity, imports and money demand (and nominal interest) functions are cointegrated, as revealed by Johansen trace (cointegration) test (see Enders 1995) and all these equations are re-specified in an ECM using the Engle–Granger two step method (Engle and Granger 1987). Lagged residuals of stationary regressions are included as an error correction term (EC_n).

6. Estimation and evaluation of the model

The dynamic simultaneous equation model is over-identified (both rank and order condition) and therefore initially it is estimated by two-stage least squares (2SLS). A modified 2SLS-Cochrane-Orcutt procedure (CORC) (see Ramanathan 1992; Pindyck and Rubinfeld 1991) is subsequently used to re-estimate all equations because autocorrelation is found to be present. The Shazam econometric package is used to estimate the model. The signs of estimated coefficients are consistent with prior expectations and most coefficients are statistically different from zero at usual levels of significance. Parameter estimates and their standard errors are available in table 1. Various tests are conducted to detect heteroscedasticity, autocorrelation, non-normality, other possible forms of model mis-specification and to measure predictive accuracy and goodness-of-fit and results are reported in table 2.

Disturbance terms in all equations, except investment and imports, are homoscedastic, as revealed by the Breusch-Pagan-Godfrey (BPG) and Engle's autoregressive conditional heteroscedasticity (ARCH) tests (table 2). The BPG test results suggest that error terms in investment and imports

Table 1 Parameters estimates with 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_2	0.0345	0.0314	1.09
PI_{t-6}	β_2	0.2957	0.2378	1.24
PS_{t-6}	χ_2	0.0047	0.0028	1.69*
EX_{t-6}	δ_2	−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	β_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†				$DF = 59$
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**

Notes: * Significant at 5 per cent; ** Significant at 1 per cent
† Equation derived by solving money demand equation

Table 2 Results of diagnostic and evaluation tests

Details	Consumption		Investment		Exports (*TXQI*)		Imports		Money demand		Employment (%)		Inflation (%)	
Model	AR(4)[1]		ECM[2]-AR(4)		ECM-AR(4)		ECM-AR(4)		ECM-AR(4)		AR(4)		AR(4)	
Goodness of Fit	DF		DF		DF		DF		DF		DF		DF	
R-Square	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-Square (adjusted)		0.55		0.62		0.45		0.59		0.81		0.66		0.61
Test for autocorrelation														
LM Test-Chi-square $DF = 4$		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
NormalityTest –Chi-square														
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	

Notes: * Significant at 5 per cent.
AR(4) — Autoregressive (Fourth Order) Model
ECM — Error Correction Model
BPG — Breusch-Pagan-Godfrey Test

equations are homoscedastic whereas the ARCH test results reveal that investment and imports equations are heteroscedastic. While the BPG test is more powerful, the ARCH test is more appropriate for time series data (Kmenta 1986). According to Greene (1997), it is rarely possible to be certain about the nature of the heteroscedasticity in a moderate-sized sample (like the sample size of this study). In using Generalised Least Square (GLS) (to estimate the heteroscedastic models), he held the view that the additional variation incorporated by the estimated variance parameters might offset the gains to GLS.

A Lagrange Multiplier (LM) test is appropriate to test fourth-order serial correlation (common with quarterly time series data) in the presence of lagged dependent variables (Greene 1997; Ramanathan 1992). The LM test results suggest that error terms of 2SLS-CORC method estimate are not serially correlated (table 2). The Jarque-Bera LM test results reveal that residuals in all but three equations (consumption, imports and money demand) are normally distributed (table 2). The normality test is essentially a test of symmetry and mesokurtosis, and does not necessarily suggest what to do next (Greene 1997). With a large number of independent and identically distributed random variables, the central limit theorem provides a theoretical assumption of normality of residuals with a few exceptions. A variant of the central limit theorem suggests that even if the number of variables is not large or that the variables are not strictly independent, the sum may still be normally distributed (Gujarati 1995).

Chow test results indicate that there is no structural break in the sample period between the pre- and post- mineral boom periods (1979–86 and 1987–95). Long-run equilibrium relationships among most variables, as revealed by the cointegration test (see section 5), are also reflective of the structural stability of parameters (see Klein *et al.* 1999). A RESET test (table 2) suggests that, with the possible exception of consumption and inflation equations, no equation suffers from omitted variables, heteroscedasticity or incorrect functional form.

Finally, the usual coefficient of determination (R^2 and adjusted-R^2) has been 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)) are used to evaluate its performance. These results are satisfactory (see table 2).

7. Simulation studies

The present study makes use of a dynamic causal simulation approach to evaluate the impact of the AGPS on the macroeconomy. Parameters estimated by the 2SLS-CORC method are substituted in to the model and

solved for each endogenous variable to obtain reduced (implied reduced form)[5] 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 a price subsidy that involves dynamic long-term impacts; fundamental dynamic equations (FDE) must be therefore 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 (see Kannapiran 1998), comprises 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.

The situations of 'with' AGPS (WAGPS) and 'without AGPS' (WOAGPS) are designated factual and counterfactual (shocked) runs, respectively. Impacts of the WOAGPS shock are transmitted to the respective exogenous variables and introduced into the model to simulate the impacts for the period of the AGPS (1990–95). The WOAGPS shock affects the price support variable (*PS*) and shock is introduced through the equation for the tree crop export quantity. Shock also affects the government expenditure (on the price support) and therefore it affects the exogenous variable government consumption (*CG*) and budget deficit (*BD*). These two variables are also shocked and introduced into their respective equations. The possible impacts of the WOAGPS shock on other exogenous variables like the financial market, taxation, etc. are untraceable (due to data limitations). These impacts, however, must be negligible as the financial market is not well developed and the contribution of the tree crop industries to taxation is not substantial.

An appropriate shazam program (see Kannapiran 1998), incorporating the simulation model, is developed specifically to run various simulations. The factual and counter-factual run values of macroeconomic variables are generated using the simulation model for the period 1990–95 and their mean, standard deviation, coefficient of variation (*CV*) and annual percentage changes (between factual and counterfactual run values) for the period 1990–95 are estimated and reported in table 3.

[5] Ramanathan (1992, pp. 547–48) termed the reduced form parameters, obtained by using the 2SLS estimates, '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.

Table 3 Changes in macroeconomic variables due to removal of AGPS (WOAGPS)

Macroeconomic variables	Annual percentage change	Standard deviation	CV (%)
Private consumption	−2.3	38.5 (37.6)	45 (43)
Investment	−6.8	25.1 (25.1)	162 (151)
Tree crop exports	−38.3	2.5 (2.6)	510 (328)
Imports	−7.3	46.2 (46.7)	135 (126)
Money demand	−3.8	192.6 (195.5)	157 (153)
Interest rate	−0.01	2.5 (2.5)	75 (75)
Employment	−0.13	2.9 (2.9)	75 (71)
Inflation	−0.07	2.3 (2.4)	657 (565)
BOP	1.4*	133.2 (133.2)	2266 (1639)
GDP	−4.3	182.6 (178.6)	129 (121)

Notes: Figures in parenthesis refer to base-run values (that is AGPS)
* Percentage points change in BOP as percentage of GDP

8. Discussion

The impacts of the AGPS policy for the tree crop export commodities on some of the important macroeconomic variables and on macroeconomic stability are evaluated and the findings discussed here.

8.1 Tree crop export income

Without the AGPS, tree crop export income would decline by 38 per cent (table 3). The price support of around K44 million per year was needed to reduce a loss of tree crop export earnings by about K98 million per year. The depreciation of the kina and an increase in commodity prices (during 1994–95) reduced the difference between the guaranteed and market price, making the subsidy expenditure negligible. Without these developments, the expenditure on price support would have been around K100 million per year and it would have exceeded the gain in tree crop export earnings. The government of PNG gambled successfully on commodity prices improving; prices broke through the trigger price in July 1994 (Gupta 1995).

8.2 Private consumption

Without the AGPS, private consumption would decline by K56 million per year. The price subsidy, increased tree crop export earnings and the consequent multiplier effects enabled the rural sector to sustain higher consumption. Private consumption fluctuates slightly more in the WOAGPS situation.

8.3 Private investment

Without the AGPS, investment would decrease by 6.8 per cent (K30 million per year) because of the loss of price support and decreased export income. Proponents of the AGPS argue that the price support smooths consumption and increases investment, a proposition supported by the results. The present finding is based on a medium-term analysis (1990–95) and, therefore, further research on the spillover impacts of diversion of budgetary resources in the form of the price support over a longer period is desirable.

8.4 Imports

Removing the AGPS, by reducing private and public spending, decreases imports by K139 million per year (7.3 per cent). After accounting for a reduction in the tree crop exports by K98 million per year with removal of the AGPS (see section 8.1), net exports decrease (WAGPS) by K41 million per year. That is, the effect of price support on imports and the BOP is counterproductive.

8.5 National income

GDP declines by an annual average of 4.3 per cent under WOAGPS. Although the AGPS creates a net export deficit of K41 million, it increases the GDP through multiplier effects and the feedback from the increased private and government consumption and investment. As indicated above, a long-term evaluation is necessary to study the impact of diversion of budgetary resources in the form of subsidy.

8.6 Money demand

In the absence of AGPS, demand for money is about 3.8 per cent lower. A monetary approach to the BOP, advocated under the World Bank/IMF-sponsored SAP, suggests that a monetary expansion, under a fixed exchange rate regime, causes further deterioration of the BOP position (see Dornbusch and Fischer 1998). A similar impact was evident in PNG during 1994–95.

8.7 Nominal interest rate

The nominal interest rate is about 0.01 per cent higher with the AGPS because of the pressure exerted by the domestic financing of a budget deficit and the increased demand for money, both caused by the price support. The adverse impact of the AGPS on interest rates would be higher but for the accommodative monetary policy pursued in PNG for many years to keep the interest rate low (Carruthers 1994).

8.8 Employment rate

Employment decreases by 0.13 per cent under WOAGPS. However, the extra employment created under AGPS is ultimately caused by the price support through an expansionary budget and such an increase would be transitory without indefinite budgetary support.

8.9 Inflation rate

The inflation rate declines by 0.07 per cent under WOAGPS. The impact is negligible because the price support-induced increase in demand for domestic goods is met by domestic production and the increase in demand for imports is supplied by countries with low inflation. There is, therefore, not much imported or domestic inflation. However, under the current floating exchange rate regime, the price support-induced deterioration in the BOP position might lead to a higher inflation through the exchange rate (Kannapiran 1997) and therefore any further price support would lead to increased inflation.

8.10 Balance of payments

The BOP position improves from a deficit of 0.08 per cent of GDP under WAGPS to a surplus of 1.32 per cent of GDP under WOAGPS. Although the AGPS increases export income, it simultaneously increases imports (see section 8.4). This suggests that price support has also contributed to the worsening external balance position and an exchange rate crisis in 1994–95.

8.11 Macroeconomic stability

In order to study the impact of the AGPS on macroeconomic stability, standard deviations and coefficients of variation of all the variables studied above, under the 'with' and 'without' AGPS scenarios, are estimated and they are not statistically different (see table 3). The AGPS is not adequate to improve the macroeconomic stability as advocated by the proponents.

In summary, the AGPS favourably improved the internal balance (income

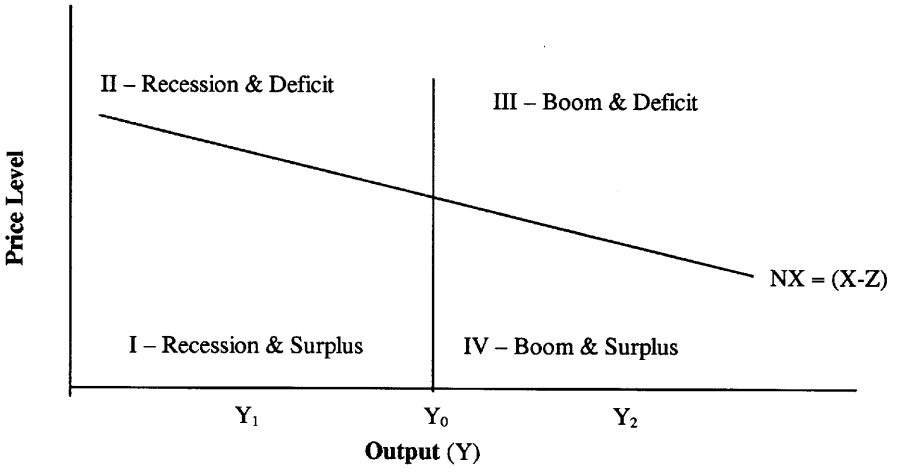

Figure 1 Policy dilemmas: targeting internal vs external balance

Source: Adapted from Dornbusch and Fischer 1998

and employment) but adversely affected the external balance and macroeconomic stability. According to Dornbusch and Fischer (1998), policies to improve external balance will worsen internal balance and vice versa. This 'policy dilemma' is illustrated in an ISLM graph (figure 1). In figure 1, there are four quadrants (I to IV) corresponding to booms (III and IV) and recessions (I and II) and external balance surpluses (I and IV) and deficits (II and III). Internal and external balance can be achieved under quadrants I and III through corrective policies: expansionary monetary and fiscal policy reduce both unemployment and the surplus in quadrant I, and contractionary monetary and fiscal policies will correct the problem in quadrant III. A policy dilemma situation arises in quadrants II and IV. Quadrant II represents the WOAGPS situation. Here the policy dilemma is whether to use an expansionary policy to achieve internal balance (output and employment) with a worsening BOP deficit (external imbalance) or to use a contractionary policy to achieve the external balance (BOP equilibrium) with an associated recession (internal imbalance). The government of PNG, by introducing the AGPS, resorted to an expansionary policy that contributed to the achievement of internal balance but adversely affected external balance, as revealed by the present study.

A devaluation of Kina by 22 per cent[6] in 1990 (instead of the AGPS

[6] There was serious discussion of devaluing the currency by 24 per cent in 1990, but this did not happen.

policy) might have reduced the BOP deficit (improved the external balance) and increased the income and employment (internal balance). As a part of the SAP, the Kina was devalued by 10 per cent in 1990 and 12 per cent in 1994. These devaluations and the depreciation of kina under the floating exchange rate regime introduced in October 1994 increased the kina value of commodity prices by 30–40 per cent in 1995, and almost restored the internal and external balances. Incidentally, commodity prices also increased in 1994–95. Without these developments, the cost of price support would have been around K100 million as in 1993 and, therefore, there would have been a negative net benefit with serious macroeconomic consequences.

9. Conclusion

Macroeconomic impacts of a price subsidy (AGPS policy) for the tree crop export commodities in PNG are evaluated, using a macroeconometric simulation, and the findings are summarised here. The price subsidy has favourable impacts on tree crop export income, aggregate demand, private consumption and investment, and employment. It increased imports (over exports), budget deficits and demand for money and adversely affected interest and inflation rates, the BOP position and macroeconomic stability. Any favourable impacts of the AGPS are highly sensitive to volatile and unpredictable commodity prices and cannot be sustained without achieving both internal and external balance and macroeconomic stability.

A policy decision concerning the AGPS must recognise the nature of conflict between achieving internal balance and external balance. Any attempt to reach one target may involve a cost in terms of the other. The government of PNG introduced the AGPS that contributed to the achievement of internal balance but adversely affected external balance. The internal and external balances reached an unsustainable level in 1989–90 and again in 1993–94. In 1994, the BOP position was negative (deficit of K168 million) and remained at a low level until 1998. Achieving fiscal balance and BOP surplus were more important policy goals at that time than output and employment (Kannapiran 1998). A devaluation of Kina by 22 per cent in 1990 (instead of the AGPS policy) might have improved the external and internal balance. In fact, the devaluation in two stages (1990 and 1994) and the subsequent further depreciation of the currency facilitated the process of restoration of internal and external balance.

An important implicit assumption in the analysis reported is that, in the absence of AGPS, the government of PNG would not have taken other policy measures to stimulate the economy. If it had taken such measures, they would have had many of the effects that AGPS had.

Finally, the macroeconomic impacts of the AGPS are evaluated against the following economic policy objectives of the PNG government:

1. achieving fiscal stability, reducing the budget deficit and balancing the budget;
2. maintaining a stable exchange rate and a stable and low level of inflation and interest rates;
3. managing the external balance with sufficient foreign exchange; and
4. eliminating export subsidies for agricultural commodities (URAA and SAP).

Empirical evidence from the study suggests that the AGPS has worked against the above policy objectives of the government, and made macroeconomic management more difficult. With the introduction of the AGPS, the government of PNG was criticised for violating the commitments made under the URAA and SAP. It is concluded that reintroduction of the price support policy would not assist in achieving PNG's economic policy objectives.

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Appendix: 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.

Behavioural equations

$$\Delta_4 CP_t = \alpha_1 + \beta_1 \Delta_4 Y_t^d - \chi_1 \Delta_4 RR_{t-4} + u_{1t} \tag{2}$$

$$\Delta_4 IP_t = \alpha_2 + \beta_2 \Delta_4 Y_t - \chi_2 \Delta_4 RR_t + \delta_2 \Delta_4 KA_{t-3} + \varepsilon_2 EC_1 + u_{2t} \tag{5}$$

$$\Delta_4 TXQI_t = \alpha_3 + \beta_3 \Delta_4 PI_{t-6} + \chi_3 \Delta_4 PS_{t-6} - \delta_3 EX_{t-6} + \varepsilon_3 EC_2 + u_{3t} \tag{8}$$

$$\Delta_4 Z_t = \alpha_4 + \beta_4 Y_t^d + \chi_4 \Delta_4 GS_{t-5} + \delta_4 EC_3 + u_{4t} \tag{9}$$

$$\Delta_4 M_t^d = \alpha_5 + \beta_5 \Delta_4 M_{t-1}^d + \chi_5 \Delta_4 Y_t - \delta_5 \Delta_4 NR_t + \varepsilon_5 EC_4 + u_{5t} \tag{11}$$

$$ER_t = \alpha_6 + \beta_6 ER_{t-1} + \chi_6 YR_{t-2} + u_{6t} \tag{16}$$

$$\Delta_4 INF_t = \alpha_7 + \beta_7 \Delta_4 M_{t-3}^d + \chi_7 \Delta_4 BD_{t-5} - \delta_7 \Delta_4 EX_t + \varepsilon_7 \Delta_4 AXP_{t-3} + u_{7t} \tag{18}$$

Identities

$$Y_t = CG_t + CP_t + IG_t + IP_t + X_t - Z_t \tag{1}$$

$$Y_t^d = Y_t - TAX_t + TRP_t \tag{3}$$

$$RR_t = NR_t - INF_t \tag{4}$$

$$X_t = TX_t + OX_t \tag{6}$$

$$TX_t = TXQI_t \times PI_t \times B \tag{7}$$

$$M_t^d = M_t^s \tag{10}$$

$$M_t^s = NFA_t + DC_t \tag{12}$$

$$NFA_t = NFR_t + BOP_t \tag{13}$$

$$BOP_t = CA_t + KA_t \tag{14}$$

$$CA_t = X_t - Z_t + NTR_t \tag{15}$$

$$YR_t = \frac{(Y_t - Y_{t-4})}{Y_{t-4}} \times 100 \tag{17}$$

Description and classification of variables

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 = Real 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

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 predetermined or exogenous.

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