MACRO AND MICRO IMPACTS OF STRUCTURAL REFORMS IN PAPUA NEW GUINEA: A COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

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The Papua New Guinea economy has been subjected to a series of external shocks, starting with the Bougainville war in 1989. The government has responded with a series of structural reforms, with the most recent one being implemented in 2000. This paper employs a computable general equilibrium model to evaluate the impacts of the government's reform policies. Policies simulated are reduction in current government expenditure, reduction in real wages, tariff cuts and a goods and services tax. The results show that the export-oriented and government sectors benefit. However, the service sectors are adversely affected. While the rural population could benefit from the reforms, a case is made for increased government investment spending in these areas to stem the rural-urban drift.

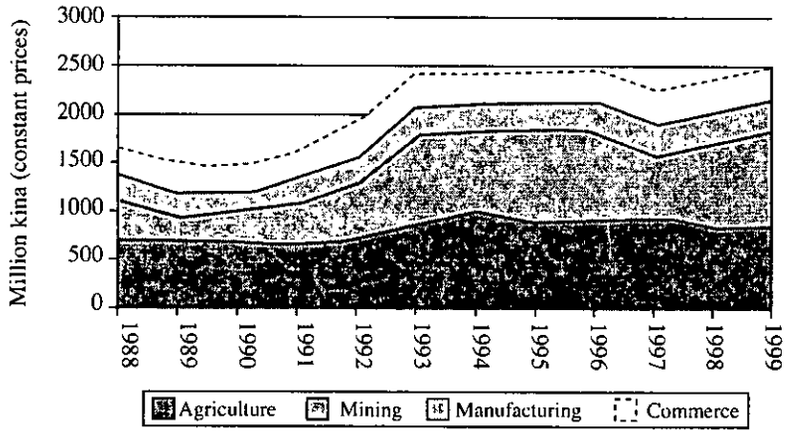
1. INTRODUCTION

Papua New Guinea (PNG) is the largest country in the South Pacific region. The country is well endowed with large reserves of renewable and non-renewable natural resources which include oil, gas, gold, copper, timber, agricultural and marine resources. Papua New Guinea's marine and coastal resources are the most extensive and diverse in the South Pacific region. Agriculture is the dominant sector, accounting for about one-third of GDP and providing wage employment for seventy-five percent of the working population (Department of Finance and Treasury, 2000). However, since the early nineties, mining and oil have made an increasing contribution to national output, and the share of agriculture has declined (Figure 1).

The manufacturing sector which contributes about 10 percent of GDP has remained static for a long period. In terms of foreign exchange earnings, the minerals sector can be considered as the backbone of the Papua New Guinean economy. Minerals account for about two-thirds of total exports while agriculture and forestry account for one-third. Since 1992, petroleum exports have grown in significance and now account for a third of mineral exports. The agricultural sector has been in decline due to a combination of external and internal factors. Average world market prices for PNG's main agricultural exports of coffee, copra and palm oil have fallen by between 50 and 60 percent in real terms.

FIGURE 1

CONTRIBUTION TO GROSS DOMESTIC PRODUCT BY AGRICULTURE, MINING AND PETROLEUM, MANUFACTURING AND COMMERCE (1988-1999)



Source: Bank of Papua New Guinea (2000).

In spite of the immense potential, PNG's economic development since obtaining independence from Australia in 1976 has been below expectations. Life expectancy and adult literacy rates are well below those of neighbouring countries in the South Pacific and Southeast Asia. Papua New Guinea was ranked 126th out of 174 countries based on a human development index, a composite measure of per capita income, life expectancy and literacy rates (UNDP, 1995). Papua New Guinea's per capita income is less than US$900, which puts it in the "lower middle income" category by international standards.

Since the beginning of the last decade the PNG economy has suffered a series of shocks brought about by a combination of external events and poor economic management. In 1989, the economy suffered two major shocks. The first was the closure of the Bougainville copper mine which used to contribute 8 percent of GDP, 35 percent of export revenues and 12 percent of total government revenues. The second shock was a rapid deterioration in the terms of trade due to a severe slump in world commodity prices. The effect of these shocks was a rapid decline in per capita GDP to an all time low of K665 in 1990 (AusAID, 1996). The Government responded to the crisis with a package of stabilisation measures. The measures included a net reduction in government expenditures of nearly K80 million, a 10 percent devaluation of the kina, wage restraint, and tightening of monetary policy (Elek, 1991). The stabilisation measures were considered to be largely successful in restoring macroeconomic balance. After another financial crisis in 1994, a 3-year

reform program was implemented with funding from the World Bank through its Structural Adjustment Loan and the IMF through a Standby Arrangement. The current program, initiated in 2000, is a follow-up of the 1994 program.

This paper utilises a computable general equilibrium (CGE) model of the PNG economy to evaluate the macroeconomic and sectoral impacts of the government's structural adjustment program (SAP). The intention is to assess the burden of adjustment and to make recommendations for economic policy. The remainder of the paper is organised as follows. Section 2 presents the modelling approach which includes a description of the model structure, model closure and data sources. Section 3 presents an outline of the simulation scenarios while section 4 presents and discusses the simulation results. The summary and conclusions are contained in the final section.

2. MODEL DESCRIPTION

The model used in this study was originally developed by the National Centre for Development Studies (NCDS) at the Australian National University (Vincent et al., 1991; Woldekidan, 1993). The PNG model is a static model based on the Johansen approach to applied general equilibrium modelling (Johansen, 1960; Dixon et al., 1982).[1] In this approach, the optimising behaviour of economic agents – consumers, producers and government – is represented by a system of equations which is non-linear in variables which is then totally differentiated to produce a system linear in percentage changes of the variables.[2] Simple matrix manipulation methods are then used to generate solutions.

2.1. Model Structure

The PNG model consists of 37 domestic industries, 34 commodities and 4 labour types. Due to the importance of agriculture in PNG's economy, this sector is disaggregated into smallholder and plantation subsectors for each of PNG's main export crops – coffee, cocoa, palm oil and copra. A list of the commodities and industries is given in Appendix Table 1. The model's equations are divided into seven major blocks: (i) commodity and factor demands; (ii) commodity supplies; (iii) zero pure profits; (iv) market clearing; (v) government sector; (vi) foreign sector; and (vii) miscellaneous equations. A stylised version of the model's equations is provided in Appendix Table 2 and a list of variables is provided in Appendix Table 3.

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1 The Johansen approach can be contrasted by another approach in which the system of equations is solved in the levels of its variables. This approach which is commonly used by the World Bank (Dervis et al., 1982) produces exact solutions. However, it requires the construction of tailor-made solution algorithms that may need to be changed after any changes in model specification.

2 A more recent version of the PNG model has been developed to investigate the economic impacts of crime (Levantis, 1998). The main difference between the model used in this study and the Levantis model is the inclusion of crime and the informal sector in the latter's model.

The model assumes a constant returns to scale production structure. Inputs utilised for production consist of intermediate inputs and primary factors. The latter include capital, labour and land. Intermediate inputs are derived from two sources – domestic and imported – and are assumed to be substitutable. The production structure may be represented by a sequence of nests. At the top level, 34 commodity composites and a primary factor composite are combined using a Leontief production function. Each commodity composite is a constant elasticity of substitution (CES) aggregation of a domestic good and the imported equivalent. The primary factor composite is a CES aggregation of land, capital and composite labour. Composite labour is a CES aggregation of occupational labour types from domestic and foreign sources.

Commodity and factor demands

The model recognises six categories of demand for commodities: demands for intermediate inputs; demands for labour, fixed capital and land; demands for inputs to capital creation; household demands for commodities; other demands and export demands. Equations 1 and 2 (Appendix Table 2) are aggregations over the six domestic sources of demand for the 2n commodities recognised in the model (n domestically produced and n imported). Export demand is shown separately in Equation 4.

Equation 3 indicates that demand for primary factors (labour, capital, land) depends on domestic industry activity levels and factor prices. Thus, demand for primary factors is explained by the level of output (scale effect) and the relative prices between domestic and imported inputs (substitution effects). It is assumed that while factors can be substituted for each other, they cannot be substituted for intermediate inputs. Hence, factor prices do not appear in commodity demand equations (1) and (2).

The export equation (Equation 4) indicates that PNG depends on world prices for her exports. The small country assumption is invoked here. That is, PNG's share of world exports is not large enough to affect world prices, implying that export prices are determined exogenously.

Commodity supplies

Equation (5) is an aggregate of commodity outputs across the 37 industries. Commodity outputs are specified to depend on domestic factor inputs and prices of domestic commodities. The model allows for multi-product output by agriculture and mining but not the rest of the industries. It is assumed that producers are able to change their output mixes. This flexibility is determined by the extent of output transformation possibilities and relative prices. For example, in mining, the output transformation elasticity will be close to zero due to lack of scope for product transformation. On the other hand, agriculture will have greater flexibility in that it has greater scope to change the product mix in response to changes in output prices.

Zero pure profits

With the assumption of competitive behaviour and constant returns to scale in production, it follows that profits can only accrue to factors of production. That is,

total revenue equals total cost in production, investment (capital creation), impor and exports. Equations (6) to (9) therefore impose conditions of zero pure profit i production, consumption, exports, imports and capital creation.

Market clearing

The equations in this block (Equations 10 and 11) equate demand to supply (domestic goods, labour, capital and land, implying that factor employment leve are satisfied. It should be noted that this does not necessarily impose full employme assumptions for any factor.

The government sector

The equations in this block explain the effects of various policies and other chang on government revenues and expenditures and the net budgetary position of th government sector. Equation (12) is an identity which defines government revent to be equal to the sum of the products of the nominal values of the individual ta bases and their corresponding tax rates plus non-tax revenue. Equation (14) defin the net budgetary position of the government as the difference between aggrega government revenue and aggregate government expenditure.

Foreign sector

The foreign sector equations comprise Equation (15), the balance of trade (foreign currency units), and Equation (16), the current account. The latter is function of the trade balance and foreign grants.

Miscellaneous equations

Price indices:

Equations (17) to (19) define the GDP deflator, capital goods price index and th consumer price index (CPI). The model is unable to determine the absolute lev of prices. It does, however, determine the real exchange rate and hence the relati prices of traded and non-traded goods and services. The real exchange rate defined as the nominal exchange rate (Kina/US$) divided by the rate of inflatio as measured by the CPI. This measures gives us the relative price of tradables nontradables. The nominal exchange rate is held fixed (exogenous) and acts as th numeraire. Movement in the real exchange rate is determined by differen between the nominal exchange rate and the CPI. For example, a fall in the CI denotes an increase in (or depreciation of) the real exchange and hence a improvement in PNG's international competitiveness.

Consumption-income link:

Equations (20) and (21) describe a simple aggregate consumption functio Aggregate nominal consumption by households is assumed to be proportional aggregate household income. Changes in aggregate household disposable incon is related to changes in GDP. A shift term is added on to Equation (20) to allow th consumption-income link to be switched off by making the shift term endogenou in which case aggregate real consumption can be made to move proportionate with aggregate real investment.

Gross Domestic Product:
In Equation (22), real GDP is defined as aggregate real demand for domestically produced goods plus exports less imports.

2.2. Model Closure

The complete model contains 15,175 equations and 17,122 variables. Since there are more variables than equations, a number of variables must be set exogenously to enable a solution to be achieved. The rationale for the choice of the exogenous/ endogenous split and numeraire in this set of simulations is as follows. Since the main objective of the study is to examine the macroeconomic and sectoral impacts of the SAP, government taxes (i.e., company tax rate, mineral rents, consumption taxes, import taxes), nominal government consumption expenditure and tariffs are set exogenously. Export demand and import prices are also set exogenously on account of the small country assumption. Since population is determined by demographic factors, it is also set exogenously. Capital stock is exogenous in the short-run but made endogenous in the long run. The other exogenous variables in the model are real wages, investment and the shift variables.

The model was solved using GEMPACK v6.1, a general-purpose computer package (Codsi and Pearson, 1988). Further details about the theoretical structure and model specification for the model can be found in Woldekidan (1993).

2.3. Data Sources

The first PNG model was based on input-output data for 1988 (Vincent et al., 1991). Since then, the database has been updated to 1990 to reflect significant changes in the economy including the closure of the Bougainville copper mine and the commencement of petroleum exports (Welsch, 1993). The elasticity and parameter estimates (see Appendix Table 4) were obtained from a literature search. Since the true values of these estimates may differ from their hypothesised values, this study's results must be interpreted with caution. It would be more useful to view the results as likely effects of changes in government policy rather than as precise estimates of outcomes.

3. SIMULATION SCENARIOS

Five sets of policy simulation experiments were conducted to explore the impacts of the SAP on the PNG economy. These were:

- a 30 percent reduction in current government expenditure;
- a 20 percent decline in real wages;
- a 50 percent tariff cut across the board;
- a 10 percent consumption tax; and
- a simulation of the combined effect of these policies.

As far as possible, the magnitude of the shocks have been chosen to reflect actual economic conditions and government policies. For example, following the 1994 crisis, a mini-budget was introduced which slashed government spending by 35 percent, resulting in a reduction in the budget deficit from K242 million to K191 million. Following the results of a recent IMF study on tax and tariff reforms, the

Government introduced a value added tax (VAT) of 10 percent in 2000. The ta replaced existing provincial sales tax of 3 percent and 11 percent basic import duty

4. RESULTS AND DISCUSSION

4.1. Scenario 1: A 30 percent reduction in current government expenditure

The relative size of the government sector in PNG, measured in terms of expenditur share of GDP, has been declining since 1990. However, the size of the governmen sector is still fairly substantial compared to similar governments in the Southeas Asian region. For example, in 1994, central government expenditure was about 4 percent of GDP. In that year, total spending on wages and salaries represented 2 percent of total government expenditure while investment spending was only percent. A major aspect of the SAP includes the tightening of fiscal policies stringently controlling expenditures and retrenching labour. The impact of thi policy is simulated by reducing current government expenditure by 30 percent. Th results are reported in Table 1.

Reduction in current government expenditure has an adverse social impac since most services are publicly funded as is the case in most developing countries As can be expected, there are reductions in outputs of education, health, transportatio and utilities (see lower half of Table 1). Real output falls by 8 percent and rea household consumption declines by 24 percent. The consumer price index decline by 21 percent, suggesting that government expenditure is inflationary. The reductio in government spending causes aggregate real imports to decline by about 2 percent while aggregate real exports increase by about 5 percent, resulting in surplus in the real trade balance of K339 million. Since the PNG government is th major employer, the reduction in expenditures causes aggregate employment t decline by 9 percent.

The growth in exports is fuelled by increases in value added of the export oriented industries and some import-competing industries. There is strong growt in agriculture, forestry and fisheries with mining recording much smaller growth In the government sector, aggregate government revenue declines by about 2 percent as a result of decreases in import duties, personal income tax and rea output. However, aggregate government expenditure falls by an even greate proportion and therefore the government's budgetary position improves by K25 million.

In the long-run, the export-oriented industries expand less rapidly. Howeve the situation of the import-competing and service industries worsen with many c them contracting below their short-run levels. The impacts of this particular polic may be rationalised as follows. The reduction in government spending put downward pressure on domestic prices and wages, as indicated by the fall in CP This has a flow-on effect on labour intensive industries, particularly the rural-base sector such as agriculture and forestry. The reduction in their resource cost enhances the competitiveness of these industries, leading to an increase in outpu and exports.

The above simulation results imply that the nature of government spending more important than the magnitudes involved. Given the pattern of governmer

TABLE 1

SIMULATION RESULTS FOR A 30 PERCENT REDUCTION IN CURRENT GOVERNMENT EXPENDITURE (percentage changes)

Variable/Sector output	Short-run[a]	Long-run[a]
Macroeconomic variables:		
Real GDP	-8.00	-19.83
Real household consumption	-23.60	-37.30
Consumer price index	-21.50	-7.08
Aggregate real imports (US$)	-19.98	-20.71
Aggregate real exports (US$)	4.75	0.71
Aggregate employment	-9.42	-23.69
Real trade balance (million kina)	339.17	305.81
Agricultural output:		
Smallholder coffee	11.53	5.26
Smallholder cocoa	12.67	7.66
Smallholder palm oil	8.72	3.97
Smallholder copra	13.64	4.81
Plantation coffee	11.73	6.30
Plantation cocoa	12.10	5.35
Plantation palm oil	3.23	2.92
Plantation copra	11.86	5.44
Fishing	-9.64	-18.38
Forestry	20.74	7.23
Other output:		
Porgera gold mine	2.12	1.55
Ok Tedi gold mine	1.32	0.99
Other mining	1.56	1.72
Timber processing	7.20	-7.01
Food processing	-1.37	-13.26
Beverages and tobacco	-10.99	-31.59
Metals and engineering	6.24	-12.53
Road transport	-10.32	-33.11
Water transport	-3.13	-12.68
Air transport	-15.16	-33.05
Education	-23.28	-37.17
Health	-23.56	-37.31
Electricity and garbage	-12.17	-31.53
Commerce	-0.57	-23.04
Government admin. and defence	-22.99	-36.95
Government sector:		
Aggregate government revenue	-20.82	-22.76
Aggregate government expenditure	-36.56	-35.44
Government budget position	255.03	229.49

a: Capital is held exogenous in the short-run scenarios but is made endogenous in the long-run.

expenditure in PNG, increases in current government spending will merely caus prices and wages to rise. However, increased government investment is likely t lead to job creation. The simulation results suggest that the expenditure reductio component of the SAP will lead to a reduction in publicly funded services suc education and health. The burden of adjustment, in this case, will be borne by urba dwellers since these services are mostly available in the urban areas. There is a clea need for increased government expenditure in social infrastructure in the rura areas. Such a policy is likely to create jobs and stem rural-urban migration.

4.2. Scenario 2: A 10 percent decline in real wages

One of the key aspects of the SAP is to make the economy competitive by keepin resource costs such as wages, low. To simulate this policy, we imposed a shock of 1 percent on the economy-wide real wage. The short and long-run impacts of this polic are shown in Table 2.

In the short-run, real output increases by 4 percent and real household consumptio increases by one half of a percent. The wage reduction causes a reduction in deman for imports. Consequently, imports decline by 4 percent while exports increase by percent, resulting in a real trade balance of K121 million. The policy exerts downwar pressure on the domestic price level and therefore the CPI falls by 8 percent. Give the reduction in labour costs, aggregate employment increases by nearly 10 percen

At the sector level, there is growth in value added of all sectors as can be expectec However, the biggest increases are recorded in the labour intensive industries suc as agriculture, and forestry. Since these industries are rural based, it can be inferre that a wage reduction policy is more beneficial to rural dwellers. There is very littl growth in the mining industry which is capital intensive. In the import-competin sectors, growth is greatest in industries which utilise domestic inputs (e.g. timbe processing).

In the government sector, aggregate government revenue declines due to th decline in import duties and personal income tax. However, the policy cause government expenditure to decline at a faster rate than revenues, resulting in a surplu in the government budget of K172 million.

In the long-run, the policy causes increased growth in all sectors. Real output an household consumption increase by 9 and 6 percent, respectively. Aggregat employment increases by 15 percent and the real trade balance increases by abou K150 million. All sectors expand at much higher rates compared to their short-ru levels.

The above results support the generally held view that lower real wages increas international competitiveness and stimulate job creation. In this simulation, labou intensive rural-based industries respond much quicker to a wage reduction polic However, in the long-run, when capital is more mobile, capital-intensive industrie such as manufacturing and transportation benefit.

4.3. Scenario 3: A 50 percent tariff cut across the board

The SAP also includes a program of incremental tariff reductions. To simulate th policy, a 50 percent tariff cut across the board was applied. The results (Table

TABLE 2

SIMULATION RESULTS FOR A 10 PERCENT DECLINE IN REAL WAGES (percentage changes)

Variable/Sector	Short-run[a]	Long-run[a]
Macroeconomic variables:		
Real GDP	4.24	9.14
Real household consumption	0.56	5.70
Consumer price index	-8.20	-11.48
Aggregate real imports (US$)	-4.18	-6.31
Aggregate real exports (US$)	5.49	5.39
Aggregate employment	9.82	15.01
Real trade balance (million kina)	121.01	149.94
Agricultural sector:		
Smallholder coffee	13.51	18.45
Smallholder cocoa	14.19	25.26
Smallholder palm oil	8.56	16.54
Smallholder copra	15.32	18.33
Plantation coffee	12.65	25.66
Plantation cocoa	12.47	20.97
Plantation palm oil	3.35	11.79
Plantation copra	10.33	19.47
Fishing	1.80	5.09
Forestry	19.76	27.19
Other sectors:		
Porgera gold mine	2.47	6.37
Ok Tedi gold mine	1.62	4.13
Other mining	1.85	7.21
Timber processing	13.96	20.47
Food processing	4.45	9.04
Beverages and tobacco	1.92	7.43
Metals and engineering	9.83	19.16
Road transport	8.50	16.92
Water transport	3.86	7.32
Air transport	5.03	11.54
Education	0.86	6.08
Health	0.88	6.04
Electricity and garbage	4.37	11.48
Commerce	8.55	18.84
Government admin. and defence	0.97	6.24
Government sector:		
Aggregate government revenue	-0.52	-3.75
Aggregate government expenditure	-16.11	-14.49
Government budget position	171.86	131.94

a. Capital is held exogenous in the short-run scenarios but is made endogenous in the long-run.

TABLE 3

SIMULATION RESULTS FOR A 50 PERCENT TARIFF CUT ACROSS THE BAORD (percentage changes)

Variable/Sector	Short-runa	Long-runa
Macroeconomic variables:		
Real GDP	3.64	9.25
Real household consumption	-0.15	4.96
Consumer price index	-50.52	-46.42
Aggregate real imports (US$)	4.89	-1.17
Aggregate real exports (US$)	16.33	13.50
Aggregate employment	6.45	12.39
Real trade balance (million kina)	108.67	164.23
Agricultural sector:		
Smallholder coffee	28.07	34.71
Smallholder cocoa	28.88	52.11
Smallholder palm oil	24.21	35.98
Smallholder copra	32.16	31.44
Plantation coffee	32.04	62.32
Plantation cocoa	30.62	44.27
Plantation palm oil	9.02	30.43
Plantation copra	32.46	47.30
Fishing	-0.06	2.54
Forestry	56.80	62.70
Other sectors:		
Porgera gold mine	7.36	30.57
Ok Tedi gold mine	3.68	15.33
Other mining	5.12	23.05
Timber processing	-2.93	-2.80
Food processing	0.90	2.58
Beverages and tobacco	-0.11	3.97
Metals and engineering	-0.86	1.47
Road transport	2.48	9.25
Water transport	1.08	3.79
Air transport	0.68	6.08
Education	-0.13	4.98
Health	-0.11	5.03
Electricity and garbage	0.19	5.27
Commerce	1.60	7.69
Government admin. and defence	-0.09	5.06
Government sector:		
Aggregate government revenue	-117.78	-131.01
Aggregate government expenditure	-50.39	-42.53
Government budget position	-261.23	-437.84

a. Capital is held exogenous in the short-run scenarios but is made endogenous in the long-run.

indicate that real output increases by 4 percent while there is a marginal decrease in real household consumption. The tariff reduction puts downward pressure on resource costs and enhances the external competitiveness of traded goods. Although imports increase by 5 percent, exports increase by almost triple this amount, resulting in a positive trade balance of K109 million. Due to the lower resource costs, aggregate employment increases by 6 percent.

The tariff cut causes much higher growth in the labour-intensive industries such as agriculture and forestry. Capital-intensive industries such as mining record fairly modest growth. Protected industries (e.g. timber processing, beverages and tobacco and metals and engineering) which produce mostly for the domestic market suffer reductions in output.

While the reduction in tariffs causes an increase in government revenues from company and export taxes as a result of increased output, this is offset by the decline in tariff revenues, and therefore the government's budget position deteriorates by K261 million. This result suggests that a tariff cut must be accompanied by other policies which increase government revenues from other areas.

In the long-run, the tariff reduction policy has an increased positive impact on all macroeconomic aggregates and sectors. Real output and household consumption increase by 9 percent and 5 percent, respectively. Aggregate employment increases by 12 percent and the real trade balance improves by K164 million. In the long-run, as industries restructure their modes of production, higher levels of output are achieved. The above results suggest that tariff protection based on the 'infant industry' argument should be a short-term measure. Given the right economic conditions, a tariff cut has beneficial impacts on all sectors in the long-run.

4.4. Scenario 4: A 10 percent consumption tax

The PNG Government relies heavily on personal income taxes for its tax revenue. Since there is a high subsistence and informal sector, the tax burden is borne by a small group of tax payers. In recent years, many developed as well as developing countries have shown a tendency towards reducing emphasis on income taxes and increasing revenue from indirect taxes such as a VAT. There are mixed views in the literature about the overall effects of a consumption tax. To simulate the possible macro and microeconomic effects of a VAT in the PNG, an upward shock of 10 percent was applied to consumption taxes in the model.

The results of the simulation (Table 4) indicate that the consumption tax has a recessionary impact on the economy, with real output and household consumption declining by 5 percent and 8 percent, respectively.

The tax also has inflationary impacts with domestic prices increasing by about 11 percent. Given the fall in real output, there is a decline in demand for imported intermediate inputs. Therefore, aggregate real imports decline faster than aggregate real exports, resulting in an improvement in the real trade balance of K28 million. Aggregate employment contracts by 9 percent as a result of the tax.

At the sectoral level, there is a contraction in the output of all sectors. The agricultural and service-related sectors, which are labour-intensive, are more severely affected while the capital-intensive mining sector is less severely affected.

TABLE 4

SIMULATION RESULTS FOR A 10 PERCENT CONSUMPTION TAX (percentage changes)

Variable/Sector	Short-run[a]	Long-run[a]
Macroeconomic variables:		
Real GDP	-5.35	-12.34
Real household consumption	-7.90	-15.50
Consumer price index	10.53	17.83
Aggregate real imports (US$)	-3.70	-2.35
Aggregate real exports (US$)	-2.22	-3.55
Aggregate employment	-9.46	-17.32
Real trade balance (million kina)	28.07	-5.17
Agricultural sector:		
Smallholder coffee	-4.62	-10.13
Smallholder cocoa	-4.68	-13.91
Smallholder palm oil	-2.46	-9.51
Smallholder copra	-5.35	-10.51
Plantation coffee	-4.28	-15.06
Plantation cocoa	-4.06	-12.25
Plantation palm oil	-1.05	-6.88
Plantation copra	-3.30	-11.95
Fishing	-4.18	-9.07
Forestry	-8.08	-18.21
Other sectors:		
Porgera gold mine	-0.88	-3.76
Ok Tedi gold mine	-0.61	-2.44
Other mining	-0.67	-4.23
Timber processing	-6.78	-15.53
Food processing	-3.16	-10.00
Beverages and tobacco	-5.31	-15.81
Metals and engineering	-4.60	-17.06
Road transport	-8.77	-21.59
Water transport	-3.64	-9.02
Air transport	-8.00	-17.94
Education	-7.98	-15.69
Health	-8.07	-15.70
Electricity and garbage	-6.66	-17.50
Commerce	-5.96	-20.16
Government admin. and defence	-7.96	-15.73
Government sector:		
Aggregate government revenue	27.13	28.96
Aggregate government expenditure	-0.47	-0.63
Government budget position	191.69	206.03

a. Capital is held exogenous in the short-run scenarios but is made endogenous in the long-run.

As expected, there is a substantial increase in aggregate government revenue while there is a marginal decrease in aggregate government expenditure. Consequently, the government budget position improves by K191 million.

In the long-run the adverse impacts of the tax are more pronounced. Real output falls by 12 percent and real household consumption falls by nearly 16 percent. The CPI increases by about 18 percent and aggregate employment declines by an equivalent proportion. Aggregate real exports decline faster than aggregate real imports, causing the real trade balance to decline by K5 million.

To summarise, the simulation results suggest that a 10 percent consumption tax across the board results in an improvement in the government's fiscal position and the external trade balance. However, these improvements are at the expense of an increase in inflation, a contraction in sectoral output and a fall in aggregate employment. Using real household consumption as a proxy for consumer welfare, the results suggest that consumers will be worse off.[3] These results are at odds with some studies (e.g. Chisholm et al., 1990; Piggot 1986; Meagher and Parmenter, 1986) which argue that a consumption tax will increase real output by minimising tax distortions and that inflation will not be a problem because the rise in the CPI would be one-off in nature. On the other hand, the results are in accord with studies (e.g. Neville, 1986) which show that a consumption tax results in a decline in real output, rising inflation, and a decline in consumption.

4.5. Scenario 5: Combined effect of Scenarios 1-4

The final simulation exercise was to evaluate the combined effects of the four policies. The Johansen solution algorithm linearises the model's equations, allowing an estimate of the combined impacts of the four policies to be obtained by a horizontal summation of the individual simulation results[4]. The results of this simulation can be stylized as the impacts of the SAP. The results (see Table 5) suggest that in the short-run, real GDP declines by 5 percent and real household consumption declines by 31 percent.

Overall, the policy puts downward pressure on prices and reduces resource costs. As a result, exports grow by 24 percent and given a corresponding decline in imports, the real trade balance improves by K596 million.

At the sector level, the SAP has a positive impact on the export-oriented sectors. However, protected manufacturing sectors and the service sectors are adversely affected. The policies result in an improvement in the government's budgetary position because the decline in aggregate government revenue is offset by a decline in aggregate government expenditure. In the long-run, the results

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[3] Ideally, equivalent variation should be used as the measure of consumer welfare. However, such a measure was not specified in the model.

[4] The linearisation process involves expressing the equations in percentage change variables. Since the levels equations of the model are usually nonlinear, these results are only approximations. The GEMPACK 6.1 package allows for multi step solutions which are more accurate.

TABLE 5

COMBINED IMPACTS OF SCENARIOS 1-4 (percentage changes)

Variable/Sector	Short-run[a]	Long-run[a]
Macroeconomic variables:		
Real GDP	-5.48	-13.79
Real household consumption	-31.09	-42.13
Consumer price index	-69.69	-47.15
Aggregate real imports (US$)	-22.96	-30.54
Aggregate real exports (US$)	24.34	16.06
Aggregate employment	-2.62	-13.61
Real trade balance (million kina)	596.92	614.81
Agricultural sector:		
Smallholder coffee	48.48	48.30
Smallholder cocoa	51.06	71.11
Smallholder palm oil	39.03	46.98
Smallholder copra	55.77	44.06
Plantation coffee	52.14	79.21
Plantation cocoa	51.14	58.35
Plantation palm oil	14.55	38.26
Plantation copra	51.35	60.25
Fishing	-12.07	-19.83
Forestry	89.22	78.91
Other sectors:		
Porgera gold mine	11.07	34.72
Ok Tedi gold mine	6.02	18.00
Other mining	7.87	27.76
Timber processing	11.45	-4.86
Food processing	0.81	-11.64
Beverages and tobacco	-14.50	-36.00
Metals and engineering	10.61	-8.96
Road transport	-8.12	-28.53
Water transport	-1.83	-10.58
Air transport	-17.44	-33.37
Education	-30.53	-41.81
Health	-30.86	-41.94
Electricity and garbage	-14.27	-32.27
Commerce	3.62	-16.67
Government admin. and defence	-30.06	-41.39
Government sector:		
Aggregate government revenue	-111.99	-128.57
Aggregate government expenditure	-103.53	-93.08
Government budget position	357.36	129.62

a. Capital is held exogenous in the short-run scenarios but is made endogenous in the long-run.

suggest that the export sector continues to improve. However, industries producing for the domestic sector are worse off. Overall, there is an adverse impact on employment growth and consumer welfare.

5. SUMMARY AND POLICY IMPLICATIONS

In this study an attempt has been made to evaluate the macro and microeconomic impacts of structural reforms in PNG. This objective was achieved by performing counterfactual simulations with the aid of a CGE model of the PNG economy. The following simulations were conducted: a) a 30 percent reduction in current government expenditure; b) a 20 percent decline in real wages; c) a 50 percent tariff cut; d) a 10 percent consumption tax; and e) the combined impact of the four policies. The results indicate that, in general, the reforms improve the performance of the export-oriented sectors and the government sector. However, consumers, protected manufacturing and the services sectors suffer adverse impacts.

A number of policy implications can be drawn from the above simulation experiments. While the results suggest that lower real wages and tariffs will make PNG's traded goods more internationally competitive, the growth prospects will depend crucially on the implementation of a set of complementary policies. Basically, these other policies must address the supply-side factors that constrain growth in PNG. Such policies include improvement in public infrastructure (transport and communications), a lasting solution to the law and order problem, reform of government bureaucracy and stability in monetary, exchange rate and fiscal policies.

While the simulation results suggest that a VAT has adverse impacts, such impacts could be mitigated if the policy is accompanied by a complementary package which takes account of distributional and equity issues. There is a danger that a VAT could be viewed as a 'money making machine' for the government. The simulation in this study does not take into consideration the administrative costs of such a policy. These costs need to be addressed to determine whether this is the least cost approach to raising revenue.

The results of this study also have implications for social policy. Since about 80 percent of the population live in rural areas, the SAP could benefit these people as incomes increase through the growth of rural-based industries and employment. While the SAP seeks to curtail government expenditure, there is a need for additional government spending in the rural areas to improve health, education and transportation facilities. Provision of these services could stem the current rural-urban drift. Since most social services and formal employment are currently found in the urban areas, SAP policies such as wage restraint, and reduction of government expenditure will hit urban dwellers hardest. Higher prices for basic goods and growing unemployment will increase urban poverty, resulting in a deterioration in the law and order situation. There is therefore the need for the government to take steps aimed at mitigating the adverse social impacts of the structural reforms. Finally, there is a need for increased investment (both public and private) to stimulate job creation in areas such as small-scale businesses and cottage-type industries.

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APPENDIX TABLE 1

LIST OF COMMODITIES AND INDUSTRIES IN THE PNG MODEL

Commodity	Industry
1 Subsistence crops	1 Subsistence agriculture*
2 Non-ruminant livestock	2 Smallholder coffee
3 Coffee	3 Smallholder cocoa
4 Cocoa	4 Smallholder palm oil
5 Palm oil	5 Smallholder copra
6 Copra	6 Plantation coffee
7 Other tree crops	7 Plantation cocoa
8 Other agriculture	8 Plantation palm oil
9 Fishing	9 Plantation copra*
10 Forestry	10 Other tree crops*
11 Copper	11 Other agriculture
12 Gold	12 Fishing*
13 Other minerals	13 Forestry
14 Quarrying	14 Porgera Gold Mine
15 Timber Processing	15 OK Tedi Gold Mine
16 Food processing	16 Other mining
17 Beverages and tobacco	17 Quarrying
18 Metals and engineering	18 Timber processing
19 Machinery repairs	19 Food processing
20 Chemicals	20 Beverages and tobacco
21 Petroleum	21 Metals and engineering
22 Other manufacturing	22 Machinery repairs
23 Road transport	23 Chemicals
24 Water transport	24 Petroleum
25 Air transport	25 Other manufacturing
26 Education	26 Road transport
27 Health	27 Water transport
28 Electricity and garbage	28 Air transport
29 Building and construction	29 Education*
30 Commerce	30 Health*
31 Finance and investment	31 Electricity and garbage*
32 Govt. admin. and defence	32 Building and construction
33 Other services	33 Commerce
34 Oil	34 Finance and investment
	35 Govt. admin. and defence*
	36 Other services
	37 Oil

* Indicates that investment in this industry is exogenous.

APPENDIX TABLE 2

SCHEMATIC REPRESENTATION OF THE MODEL EQUATIONS

Commodity and factor demands

1. $D = f_1(Z, P_d, P_m)$
2. $M = f_2(Z, P_d, P_m)$
3. $L = f_3(Z, P_l)$
4. $X = f_4(P^f_x)$

Commodity supplies

5. $Y = f_5(L^*, P_d)$

Zero pure profit

6. $V(P_d) = W(P_d, P_m, P_l)$
7. $P_d = P^f_x + \phi + v$
8. $P_m = P^f_m + \phi + t$
9. $K = h(P_d, P_m)$

Market clearing

10. $Y = D + X$
11. $L = L^*$

Government sector

12. $GR = \sum_{i=1}^{n} R_i r_i$
13. $GE = f_6(Y, P_d, P_m)$
14. $FB = GR - GE$

Foreign sector

15. $TB = P^f_x X - P^f_m M$
16. $CA = f_8(TB, FG)$

Price Indices

17. $\varepsilon_1 = f_9(P_d)$
18. $\varepsilon_2 = f_{10}(K)$
19. $\varepsilon_3 = f_{11}(P_d, P_m)$

Consumption-income link

20. $C = f_{12}(Y_d, qc)$
21. $Y_d = f_{13}(GDP)$

Gross Domestic Product

22. $GDP = D + X - M$

APPENDIX TABLE 3

LIST OF MODEL VARIABLES

Variable	Definition
D	Demand for domestically produced commodities
Z	Domestic industry activity levels
P_d	Domestic prices of domestic commodities
P_m	Domestic prices of imported commodities
X	Demand for exports
M	Demand for imports (volume)
L	Demand for primary factors
P_l	Prices of primary factors
P^f_x	Foreign currency prices for exports
P^f_m	Foreign currency prices for imports
L^*	Factor employment levels
Y	Commodity output levels
R	One plus ad valorem rates of export subsidy (tax)
ϕ	Nominal exchange rate (kina/US$)
t	One plus ad valorem tariff
K	Cost of capital
GR	Government revenue
GE	Government expenditure
FB	Government fiscal balance
R	Individual tax bases
r	Individual tax rates
TB	Trade balance
CA	Current account
FG	Foreign grants
ε_1	GDP deflator
ε_2	Capital goods price index
ε_3	Consumer price index
K	Cost of capital
C	Aggregate consumption
qc	Shift variable for consumption
Y_d	Aggregate household disposable income
GDP	Nominal gross domestic product

APPENDIX TABLE 4

ELASTICITY VALUES FOR THE PNG MODEL

Elasticity	Value
Substitution elasticities between domestic goods and imports for current production and investment	2.0
Substitution elasticities between domestic goods and imports for household consumption	2.0
Substitution elasticities between primary factors Substitution elasticities between occupations	1.5
Transformation elasticities between outputs of industries:	
Multiproduct agricultural industries	2.0
All other industries	0.0
Reciprocal of export demand	0.05
Frisch parameter	-6.0
Household expenditure:	
Subsistence crops	1.0
Agriculture, forestry, fishing	0.65
Food	0.65
Beverages	0.87
Manufactures	1.16
Transport	1.86
Education, health, government administration	1.06
Other services	1.16

Sources: Dixon *et al.* (1982), Lluch *et al.* (1977); and Vincent *et al.* (1991).