

# Inflation targeting policy in Papua New Guinea: an econometric model analysis

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Papua New Guinea has not explicitly endorsed inflation targeting (IT) policy but it continues to pursue a policy framework that enables maintenance of low and stable inflation. A simple econometric model of inflation in Papua New Guinea is developed and analysed to identify the appropriate policy option to manage inflation. The model provides the basic structure to study the determinants and process of inflation and to analyse how inflation responds to macroeconomic movements in the economy. Based on the analysis, it is concluded that in the medium term, Papua New Guinea should probably continue to rely on a simpler and less demanding monetary policy framework than venturing into IT policy.

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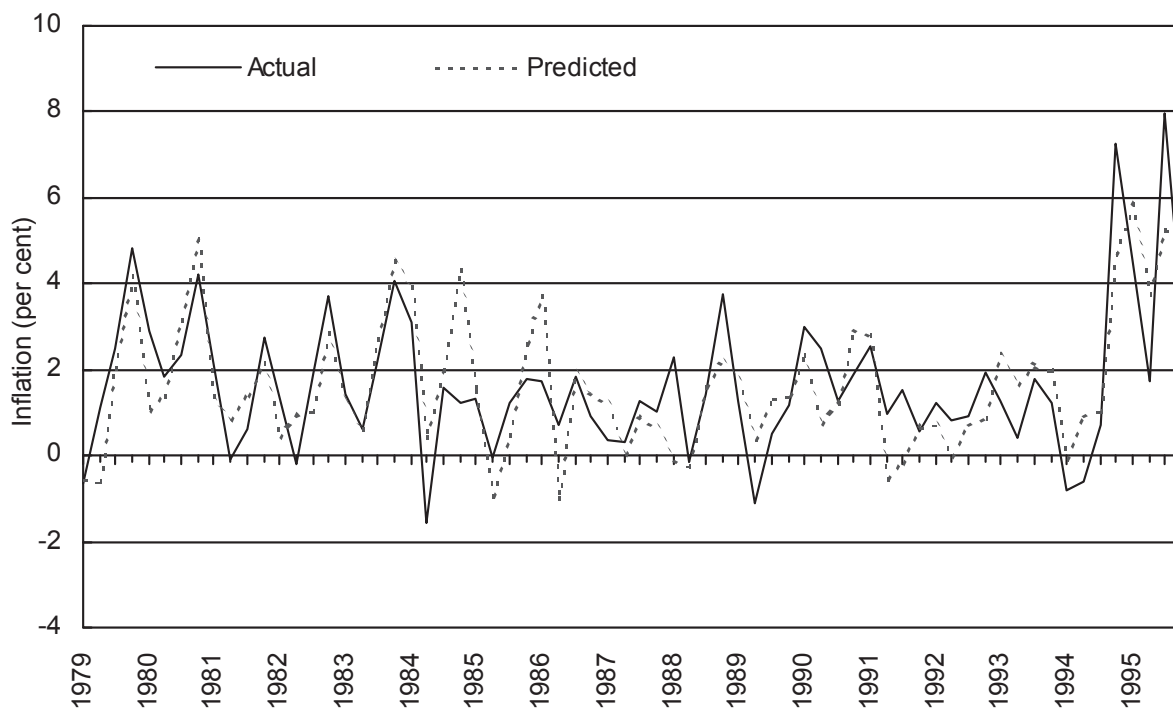
In Papua New Guinea, inflation was relatively low during the period from 1975 to 1993 (Figure 1). Over the years, the Government of Papua New Guinea has continued to pursue policies that have been targeting a relatively stable and low level of inflation (Carruthers 1994). This policy of targeting inflation is obviously intended to anchor inflationary expectation and to develop confidence in the conduct of monetary policy. The recent volatility of the exchange rate, which depreciated from 1 kina = US\$0.90 in 1994 to an historically low level of 1 kina = US\$0.32 in 1999, is of serious

concern. 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. The declining currency value coupled with a higher (imported) inflation, ultimately affected macroeconomic stability (Kannapiran and Wosae 1995; Fallon et al. 1995). Macroeconomic stability—judged in terms of a stable and low inflation rate, sustainable balance of payments and low fiscal deficit—is a prerequisite for economic growth but it provides no guarantee that growth will occur (King 1997).





Figure 1 Actual and predicted values of inflation rates, 1979–95 (per cent)



Source: BPNG and author's estimates based on his inflation model of Papua New Guinea.

Since 1994, monetary authorities in Papua New Guinea have focused their policies on targeting a low and stable level of inflation. When presenting the 1998 Supply Bills and Revenue Reform Speech, the Minister for Finance stated the government policy objectives of reducing the rate of inflation from 18 per cent in 1995 to below 5 per cent in 1997 (Papua New Guinea Department of Finance 1997). Prime Minister Sir Mekere Morauta, while presenting the 1999 mini-Budget, emphasised three economic objectives that include controlling the inflationary pressure (Morauta 1999). The design and implementation of these policies and reforms, that target the easing of inflationary pressure, must be based on a clear understanding of the determinants of inflation, the behaviour of macroeconomic variables and their inter-relationships, and

the process of inflation. This process has been facilitated by the development of an economic model of inflation that provides a conceptual framework organised around the behavioural relationships of economic variables.

### Inflation targeting policy

Under the inflation targeting policy regime, the main objective of monetary policy is to attain and preserve a low and stable rate of inflation. As a monetary policy framework, it has facilitated control of inflation and made monetary policies more transparent and accountable. This policy was mainly adopted as a response to the difficulties encountered in conducting monetary policy using an exchange rate peg or some monetary





aggregate as the main intermediate target (Debelle and Stevens 1995; Masson, et al. 1997).

A Joint Economic Committee Report submitted to the US Congress (Saxton 1997) highlighted the advantages of IT policy *viz.* price stability, as it allows the price system to function effectively; promotes economic and financial market stability and growth; and leads to lower interest rates and fosters sustainable economic growth. The report also indicated that the policy promotes transparency, accountability and credibility to monetary policy. Similar views have been expressed by Mishkin and Posen (1998) and Svensson (1999).

New Zealand, Canada, the United Kingdom, Sweden, Finland, Australia, Spain and Israel are some of the countries to have adopted an explicit IT policy. 'The gain in popularity of inflation targets can perhaps best be seen as a step in the evolution of monetary policy regimes in countries which have battled to achieve or maintain monetary and price stability in the past couple of decades' (Debelle and Stevens 1995). The inflation objective in Australia is to maintain an average rate of increase in consumer prices of around 2 to 3 per cent over the medium term.

The IT policies emphasise the following four basic propositions (Masson et al. 1997)

- An increase in the money supply is neutral in the medium-to-long run. This means that money supply increases have lasting effects only on the price level, not on output or employment.
- High and variable inflation is costly in terms of either the allocation of resources or long-run growth in output, or both.
- Money is not neutral in the short run. In other words, monetary policy has important transitory effects on a number of real variables, including output and unemployment. There is, however, still an imperfect understanding of the nature and size of these effects, their time frame, and the means by which monetary

impulses are transmitted to the rest of the economy.

- Monetary policy affects the rate of inflation with lags of uncertain duration and varying strength. These lags make it difficult, if not impossible, for the central bank to control inflation on a period-by-period basis.

There are two prerequisites for implementation of the policy

- The independence of the central bank with technical and institutional ability to model and forecast domestic inflation and to set the inflation target.<sup>1</sup>
- Authorities should refrain from targeting the level or path of any other nominal variable, such as wages or the nominal exchange rate.<sup>2</sup>

Having satisfied the prerequisite conditions, the authorities must set up a monetary policy framework with the following four essential elements (Masson et al. 1997)

- explicit inflation targets for some period or periods ahead
- clear and unambiguous indications that attaining those inflation targets is the over-riding objective of monetary policy
- a model for forecasting inflation that uses relevant variables and information indicators
- a forward-looking operating procedure in which the setting of policy instruments depends on assessing inflationary pressures and where inflation forecasts are used as the main intermediate target of monetary policy.

Although the monetary authorities in Papua New Guinea have emphasised a policy of low and stable inflation, the IT policy has not been made explicit under the monetary policy regime. Apparently, the monetary authorities must develop their technical and institutional ability to model and forecast domestic inflation, to assess the effect of instrument changes on future inflation and how the monetary impulses





affect the main macroeconomic variables. In order to provide support for technical and institutional capacity building in Papua New Guinea, an econometric analysis is undertaken and the findings are reported in this paper. An econometric model of inflation in Papua New Guinea is used to identify the determinants of inflation and the inflation process, to make forecasts and to assess the feasibility of implementing the IT policy. The approach taken in this study involves three steps

- developing and estimating an appropriate inflation model and evaluating the model
- studying the process and determinants of inflation and forecasting of inflation
- evaluating the policy options for targeting inflation in Papua New Guinea.

### Inflation models

The conceptual framework of various models of inflation proposed by monetarists, fiscalists, structuralists and others, are briefly discussed in this section. Fischer and Friedman advocated the quantity theory of money as the right model to determine price levels (Dornbusch and Fischer 1990). Monetarists believe that inflation is a monetary phenomenon, and that the fiscalist arguments regarding 'demand-pull' and 'cost-push' inflations are ultimately influenced through monetary disturbances. Monetarists hold the view that a budget deficit has no direct impact on inflation. Inflation occurs when the quantity of money expands faster than output, and that changes in taxation affect inflation if these changes affect the output. Therefore, the determinants of monetary growth are indirectly responsible for the inflation. Keynesians, on the contrary, believe that fiscal and monetary policies influence inflation by first affecting the level of excess demand. Structuralists continue to argue that inflation is caused by factors such as sectoral differences in

productivity, uniform rate of growth of money wages, sectoral differences in prices and income elasticity of output, and limited flexibility of prices and wages among sectors (Streeten 1962; Baumol 1967; Maynard and Ryckeghem 1976). The uniform rate of growth of wages is central to the Hicks–Tobin hypothesis of structural inflation.

Harberger (1980) identified the connection between the rate of inflation and rate of monetary expansion. According to him, the rate of price increases tends to exceed the rate of monetary expansion under acute inflation, while the reverse is true for chronic inflation. Budget deficits financed by the banking system are thus a dominant source of increases in money supply, which fuel most major bouts of inflation. A small country with a fixed exchange rate—such as Papua New Guinea where a fixed exchange rate regime was in place until September 1994—will normally be in the process of importing world inflation. Under the Scandinavian model (Frisch 1983), inflation is associated with a continued increase in labour costs and relative prices of the 'exposed or traded or export–import sector', and the 'sheltered or non-traded sector'.

The Phillips–Lipsey model interprets inflation as a demand-determined phenomenon (Frisch 1983). The classical quantity and monetarist theories of inflation commonly have the principle that the rate of increase of inflation corresponds exactly to the difference between the rate of expansion of money supply and the rate of real growth; that is, the income elasticity of money demand (Frisch 1983). Leamer (1986) illustrated a general model of inflation with variables each having their own distributed lag. He included lagged inflation rates (formation of inflation expectation), growth rates of money, unemployment rates, budget deficit scaled by gross national product (deficit/GNP), oil prices and price controls in the United States.

Coppin (1993) studied the determinants of inflation in Barbados, which is a tourism-





oriented small and open economy. He indicated that the demand side effects, such as the level of real tourism activity, and supply side effects, such as the levels of imported inflation and interest rates, are important determinants of inflation. He also observed that models of inflation in Caribbean countries have tended to focus on import prices, taxes, interest rates and wages as the primary determinants of movements in domestic prices. Sowa (1994) used an error correction model applying the Engle–Granger method to model inflation in Ghana. He estimated inflation as a log-linear function of nominal money, real income and the parallel exchange rate. As the real interest rate continued to be negative for a long period, the real exchange rate (parallel rate) has been featured as an indication of the opportunity cost of holding money.

Ubide (1997) studied the determinants of inflation in Mozambique and found monetary variables were some of the key determinants of inflation. An econometric analysis of Turkish inflation by Lim and Papi (1997) found that monetary variables (initially money, and more recently, the exchange rate) play a central role in the inflationary process, and public-sector deficits are found to have an important direct effect on inflation. They also concluded that on several occasions, exchange rate depreciation has also contributed to the inflationary process.

Durevall and Ndung'u (1998) developed an error correction model and analysed the behaviour of prices in Kenya during 1974–96. They found that in the long run, inflation emanates from movements in the exchange rate, foreign prices and terms of trade, and that the money supply and the interest rate influence inflation in the short run. They also suggested that the exchange rate is likely to be a more efficient nominal anchor than money supply, and that inflation could be made more stable by policies that secure the supply of maize during droughts.

### **Inflation model of Papua New Guinea**

In Papua New Guinea and other developing economies, higher levels of unemployment and inflation coexist and the labour market is not highly competitive. Despite a recent wage liberalisation policy, a high level of unemployment and higher wages coexist in Papua New Guinea. Given the level of structural and wage rigidity, and the imperfections in the labour market, especially for skilled labour, the relevance of the Phillips curve at this stage of development is doubtful. The long-term equilibrium may be appropriate in industrial economies where the economy is nearing full employment levels.

In the present model, wages and interest rates are assumed to feed inflation through the mechanisms of government expenditure, private consumption (mainly through imports) and monetary movements. Sustained monetary expansion ultimately translates into increased inflation. Financing of an inflation-induced budget deficit would increase money supply and generate further inflation (Aghevli and Khan 1980). Overseas aid, loans and grants account for more than 30 per cent of Papua New Guinea's budget. They are included as part of budget revenue, and are then appropriated. Aid and grants that are influenced by non-economic considerations, or are sometimes policy-driven, are not included in the revenue side in order to reflect the real situation. The budget deficit, as disclosed in the budget document, may not reveal the real situation of the deficit. Therefore, for the purpose of this analysis, the total internal revenue (exclusive of aids and grants), minus expenditure, is considered a deficit. Any change in taxes, as a part of fiscal policy, affects inflation but it might pass through the fiscal expansion. The monetary expansion and fiscal deficits are, therefore, considered important determinants of inflation in Papua New Guinea.





In Papua New Guinea, any increase in aggregate demand for traded goods is met mostly by imports. The demand for non-traded goods is met by increasing the under-utilised capacity of domestic industries. Simultaneously, the frequent disturbances of aggregate demand caused by export income variability, coupled with supply rigidity, must add to inflation. However, if increased demand is met out of imports, then inflation is mainly imported. The imported component of inflation is represented in the model by the import price and real exchange rate. As Australia is a major source of imports, Australian prices (inflation) are imported into the economy of Papua New Guinea. The price index for imports from Australia is another important determinant of inflation. In the absence of an import price index, the Australian export price index is considered to be a reasonable proxy.

In a small, open economy such as Papua New Guinea's, monetary and fiscal expansion normally affect the level of imports and, through that mechanism, the balance of payments under a fixed exchange rate regime. Under a floating exchange rate regime, an increase in imports over exports leads to downward movements in the exchange rate, thereby affecting the balance of payments. In this process, there will be upward pressure on general prices brought about by the exchange rate depreciation, ultimately leading to inflation. The level of variation in the real exchange rate is normally reflected in the level of inflation, therefore it is appropriate to include the real exchange rate as a determinant of inflation. There must be a negative response of inflation to the growth of the non-mining sector in Papua New Guinea. This may have been due to an increased supply of non-traded goods and import substitutes.

### Formation of expectations

Most developing economies, including Papua New Guinea, are characterised by processes of expectation formation that are quite different

from processes found in the more developed world. According to Pesaran (1987), for example, economic agents in developing countries may be prevented from forming rational expectations because of a lack of information and expertise. Fair (1984) raised doubts about the modeling of rational expectations even in an industrial economy. Accordingly, the present inflation model of the PNG economy is built around the simplifying assumption that expectations are naive.

### Structural break

There are chances of other external influences by qualitative events such as macroeconomic policy changes and politically directed intervention on the time-series data (1975–95). While analysing the impact by using regression models, the disturbance term might pick up the influence of those exogenous variables affecting the endogenous variables that have not been included in the regression equation (Gujarati 1988). In order to isolate the macroeconomic relationships, all other economic influences must be the same during the period of study. The following events are the most relevant changes that might have influenced the economic variables and might have affected the stability of the parameter estimates during the study period

- the pre (1975–86) and post-mineral (1987–95) boom period data
- the Bougainville insurgency in 1988 that led to the closure of the copper mine and the loss of export earnings (copper, cocoa and copra) from Bougainville
- the exchange rate was devalued twice (1990 and 1994), and there was a shift from a fixed exchange rate regime to a floating exchange regime in September 1994
- the fiscal policy was also changed by different governments, according to the ideology of the political parties in power, and there were structural adjustment programs undertaken twice during these



Table 1 **Augmented Dickey–Fuller unit root test results** (three lags)

Variables (differenced once)	<i>t</i> -value with no trend	<i>t</i> -value with trend
Rate of inflation (INF)	-7.554	-7.728
Australian export price index (AXP)	-4.514	-4.836
Demand for money (M)	-3.080	-4.853
Budget deficit (BD)	-8.098	-8.079
Real exchange rate (EX)	-3.714	-3.720

**Notes:** Asymptotic critical values at 10 per cent; constant with no trend = -2.57; constant with trend = -3.13.

periods (1988–91, and since 1994). The varying fiscal deficits must have played an important role in shaping the macroeconomic settings.

The pre and post-mineral boom period is given as the breakpoint to test for the predictive stability and the structural break in the model caused by all the events explained above.

In summary, inflation in Papua New Guinea is influenced by three components—fiscal, monetary and external (imported) (see also Leamer 1986). The fiscal or budget deficit affects inflation but the response takes at least five quarters. This expectation of lag structure is based on the time difference (about five quarters) between budget appropriation and the actual expenditure. The next component is the monetary expansion that will have a lagged influence on inflation. The imported component of inflation is represented in the model by the import price and real exchange rate. Increases in Australian prices are imported into the PNG economy after ‘*n*’ periods (the time lag between the imported stock turnover in the domestic market and arrival of new imports). The real exchange rate is also included as an explanatory variable in US\$ per kina. It negatively and immediately affects inflation as the traders normally try to pass the impacts to the consumers immediately.

Inflation in Papua New Guinea is expected to be positively correlated with

monetary expansion ( $M = M^d = M^s$ ), the budget deficit (BD), and the Australian export price index (AXP), and negatively correlated to the real exchange rate in US\$/K (EX). There will be lagged response to M, BD and AXP and, therefore, lagged variables (lagged by ‘*n*’ times where ‘*n*’ is unknown and to be tested) are included. The response of inflation to the exchange rate is specified to be instantaneous as the exchange rate is expected to affect prices immediately.

Based on the above discussions, the inflation model of Papua New Guinea<sup>3</sup> is specified in Equation 1.

$$INF_t = f(M_{t-n}^d, BD_{t-n}, EX_t, AXP_{t-n}) \quad (1)$$

where:  $M_{t-n}^d(+)$ ,  $BD_{t-n}(+)$ ,  $EX_t(-)$ ,  $AXP_{t-n}(+)$

### Model transformation

The economic model (Equation 1) is transformed into an econometric model before estimation using various econometric procedures explained here. A linear functional form is used for econometric specification of the model and additive error terms appended to the equation. Quarterly time series data collected for the period 1975–95 are used in the model.

### Unit root and stationary variables

Most time-series economic variables follow a random walk process (non-stationary), and using non-stationary variables in analysis





might lead to spurious regressions (Granger and Newbold 1974, 1977; Plosser and Schwert 1977). Granger and Newbold (1974) used the phrase 'spurious regression' to describe the regression of non-stationary variables. Spurious regression is normally characterised by high  $R$ -square values and  $t$ -statistics for coefficients but failure of the Durbin–Watson and other, higher order, autocorrelation tests. Variables must be stationary in order to avoid the problem of spurious regression. When they are non-stationary in level terms, their first or second differenced terms will usually be stationary (Griffiths et al. 1993; Ramanathan 1992). The order of differencing depends on the periodicity (or frequency) of data (Ramanathan 1992; Dougherty 1992). For quarterly data, fourth-order first differencing eliminates the unit root problem and first differencing under a fourth-order condition is represented by the expression,  $Y_t - Y_{t-4}$ . All variables are tested for stationarity (with three lags) before being used in the model. The Augmented Dickey–Fuller (ADF) test is used to test stationarity at levels and at fourth-order first differences of variables. The unit root test results are given in Table 1. All non-stationary variables are transformed into stationary variables by differencing once (fourth-order first differencing).

### Model selection (lag structure)

The model was specified with  $n$  lag structures, based on the theoretical explanation for lag length in the last section. The model selection tests *viz.* Shibata, AIC, Rice and Schwartz tests (Ramanathan 1992) are conducted by using different lags for variables (differenced) with lagged specification and the results are presented in Table 2. The model with the lowest value for all these selection criteria is more appropriate than the model without a lag structure or with a different lag structure. The lag length of variables as identified by the tests is used as the appropriate lag structure in the final transformation of the model. The Shazam econometric package is used to carry out all these tests (White 1993).

### Cointegration and error correction modeling

In equilibrium, there are long-run relationships among most economic variables. In a steady-state equilibrium, differencing makes the variables zero and, under those circumstances, regression analysis cannot be carried out after differencing (with zero values). In other situations, differencing the variables to make

Table 2 Model selection (lag structure) test results

Model with different lags	Rice	Shibata	Schwartz	AIC
$INF_t = f(M_t, BD_t, AXP_t, EX_t)$	2.6693	2.6116	3.1050	2.6374
$INF_t = f(M_{t-1}, BD_{t-1}, AXP_{t-1}, EX_{t-1})$	2.8140	2.7513	3.2764	2.7794
$INF_t = f(M_{t-2}, BD_{t-2}, AXP_{t-2}, EX_{t-2})$	3.6932	3.6084	4.3041	3.6462
$INF_t = f(M_{t-3}, BD_{t-3}, AXP_{t-3}, EX_{t-3})$	3.1297	3.0556	3.6510	3.0886
$INF_t = f(M_{t-4}, BD_{t-4}, AXP_{t-4}, EX_{t-4})$	3.5922	3.4919	4.1794	3.5307
$INF_t = f(M_{t-3}, BD_{t-5}, AXP_{t-3}, EX_t)$	<b>2.3343</b>	<b>2.2838</b>	<b>2.7153</b>	<b>2.3065</b>
$INF_t = f(M_{t-4}, BD_{t-5}, AXP_{t-4}, EX_{t-5})$	3.5687	3.4788	4.1711	3.5187
$INF_t = f(M_{t-5}, BD_{t-5}, AXP_{t-5}, EX_{t-6})$	3.8401	3.7434	4.4884	3.7863

Notes: Bold letters/figures refer to the appropriate model with lowest value for all criteria of model selection.





Table 3 Results of cointegration: Dickey–Fuller and Johansen trace tests

Dickey–Fuller test with constant at 10%		Johansen test with constant $l_{\text{trace}}$ at 90 per cent				
No trend	With trend	$R_0$	$R_1$	$R_2$	$R_3$	$R_4$
-2.807	-2.5449	57.959	26.673	13.094	5.833	0.100

**Notes:** Asymptotic critical values at 10 per cent for the DF test are: with constant and no trend -4.13 ( $M = 5$ ); without constant and no trend -4.43 ( $M = 5$ ).

them stationary may lead to a loss of long-term impact. Granger (1981) identified a situation where the regressions among non-stationary variables are not spurious if they are cointegrated. When the linear combination of the variables is stationary, the variables are said to cointegrate and then an error correction model must be appropriate. If the variables are cointegrated, the linear combinations are called the equilibrium errors and will be stationary. If the variables integrated are of different orders, they are not cointegrated (Enders 1995). Linear combinations of the variables of the equation are tested for cointegration using the Dickey–Fuller cointegrating regression and Johansen trace tests (Enders 1995), and the results suggest that inflation function is not cointegrated. Johansen test critical values with constant ( $l_{\text{trace}}$  at 90 per cent) are:

$$R_0 = 71.472 \quad R_1 = 49.925 \quad R_2 = 32.093 \\ R_3 = 17.957 \quad R_4 = 7.563$$

## Model estimation

The quarterly econometric model with fourth-order first differenced variables is furnished in Equation 2. After differencing and other transformations, a complete data set was available for the period 1979–I to 1995–IV and, therefore, the final sample size is 68 (Kannapiran 1998). All variables used in the model are in real terms and  $\Delta_4$  stands

for fourth-order first difference ( $X_t - X_{t-4}$ ).

$$\Delta_4 INF_t = \alpha + \beta \Delta_4 M_{t-3}^d + \chi \Delta_4 BD_{t-5} - \delta \Delta_4 EX_t + \varepsilon \Delta_4 AXP_{t-3} + u_t \quad (2)$$

As all the variables in the final functional Equation 2 are stationary, the ordinary least square (OLS) method gives consistent and valid estimates (Enders 1995) and, therefore, the equation is first estimated using the OLS method. In time series quarterly data, auto-correlation of the disturbance term is common. As quarterly data are used in this study, there is a likelihood of fourth-order auto-correlation (Dougherty 1992; Ramanathan 1992). The Durbin–Watson (DW) test may not be valid to test the higher order processes and, therefore, the Lagrange multiplier test (LM test) is appropriate to detect fourth-order auto-correlation (Greene 1993; Dougherty 1992; Ramanathan 1992). Although the LM test is a large sample test, it has been found to be useful even if the number of observations is only 30 (Ramanathan 1992; Harvey 1981; Murinde 1993). The LM test for fourth-order auto-correlation reveals that the OLS residuals are auto-correlated. The standard OLS procedure is not appropriate for estimation of the auto-correlated model (in the presence of auto-correlation error).

The Cochrane–Orcut (CORC) procedure and the Hildreth–Lu (HILU) search procedure (Fair 1984; Ramanathan 1992; Murinde 1993; Greene 1993) are the two





methods considered in this study to estimate the auto-correlated model. The HILU method iterates to a global minimum whereas the CORC procedure might not iterate to the global minimum if there are many local minima. However, the HILU procedure involves hundreds of iterations for a fourth-order auto-correlation and it is highly computer intensive. The present study involves a data set with fourth-order auto-correlation. The standard econometric packages (including Shazam) do not permit the HILU method to undertake a grid search when the order is more than two (White 1993). In the present study, therefore, the CORC iterative procedure is used to estimate the auto-correlated model to eliminate the auto-correlation. The LM test for fourth-order auto-correlation confirmed the elimination of the auto-correlated error under the CORC method of estimation. The estimation is carried out in the Shazam econometric package.

## Model results and diagnostic testing

Results of the model estimation and the various diagnostic tests are presented in Table 4. The *R*-square value is 63 per cent. The calculated *F* value is higher than the critical *F* values at 5 per cent significance level, thereby indicating a significant degree of reliability of the coefficient of determination. The adjusted *R*-square value is 61 per cent and this suggests that there is no penalty for the number of explanatory variables that are used (Table 4).

- The LM test for fourth-order auto-correlation revealed that the auto-correlation error is eliminated.
- The disturbance term is homoscedastic, as revealed by the BPG and ARCH tests. The BPG test is reasonably powerful whereas the ARCH test is relevant for time-series data (Kmenta 1986).

RESET results reveal that the calculated *F* value for RESET (three) is significant and marginally higher than the critical values at 5 per cent. As reported by Gujarati (1988), although the test reveals the model misspecification, it does not suggest a better alternative.

The residuals of inflation equation is normally distributed, as revealed by the Jarque–Bera LM test.

A Chow test is conducted to evaluate predictive stability and to test for a structural break in the model. The pre and post-mineral boom period is given as the breakpoint for the Chow test. The results suggest that the model equation is fairly stable.

The predictive accuracy test suggests that the Theil inequality *U* value is less than one. The model is thus reasonably accurate in prediction.

The parameter estimates, along with the standard error and the corresponding *t*-values, are given in Table 5. The signs of all estimated coefficients are as expected. In most cases, the estimated parameters of variables are significant at 1 to 5 per cent, as indicated by the *t*-values. The *t*-ratios for the variables, government budget deficit (fiscal operation), money demand (stock), and the Australian export price index, are each significant at 1 per cent level (Table 5). They are positively correlated with inflation.

There is a significant negative response to the exchange rate (US\$/kina), also at one per cent. Imported inflation plays an important role in domestic prices. The monetary factor is an important variable in determining inflation in Papua New Guinea, supporting Harberger's (1980) finding in his study in developing economies and Ubide's (1997) study of inflation in Mozambique (also see Lim and Papi 1997).

The exchange rate is a highly significant variable that increases inflation in Papua New Guinea as in the case of inflation in Turkey (Lim and Papi 1997). Its impact on inflation continues until the exchange rate





Table 4 Results of diagnostic tests

Details	Test results	
Model		AR(4) <sup>a</sup>
Goodness of fit	DF	
R-Square	4	0.63
R-Square (adjusted)		0.61
Test for auto-correlation		
LM test–Chi-square DF=4		7.12
Tests for heteroscedasticity Chi-square test		
BPG <sup>b</sup> test	4	6.86
Engle's ACRCH test	1	3.11
Specification error test (Ramsey RESET) <i>F</i> -test		
RESET (2)	1 62	2.57
RESET (3)	2 61	3.51*
RESET (4)	3 60	2.38
Normality test–Chi-square		
Jarque–Bera LM test DF-2		0.18
Structural break–Chow test		
<i>F</i> -Value	5 58	1.22
Predictive accuracy tests		
Mean absolute error		1.08
Root mean square error		1.43
Theil in equity coefficient U		0.62

Notes: <sup>a</sup>AR(4) is auto-regressive (fourth order) model

<sup>b</sup>BPG is Breusch–Pagan–Godfrey test

\* significant at 5 per cent.

Table 5 Results of parameters estimates with standard error and *t*-values

Equations	Parameters	Coefficients	Standard error	<i>t</i> -value
				DF=59
Constant	$\alpha$	-1.4512	0.32	-4.60**
$M^d_{t-3}$	$\beta$	0.0097	0.0019	5.06**
$BD_{t-5}$	$\chi$	0.0042	0.0016	2.58**
$EX_t$	$\delta$	-7.4696	1.530	-4.87**
$AXP_{t-3}$	$\varepsilon$	0.1333	0.0381	3.49**

Note: \*\* significant at 1 per cent.





adjustment is complete—by the last quarter of 1996, but again continues in 1997 due to instability in the exchange rate. This is because of import-dominated consumption that increases inflation after the devaluation. The Australian export price index (a proxy for import prices in Papua New Guinea) is also a key influence on inflation in Papua New Guinea. This finding conforms to findings of a study on the transmission of world prices by Mundlak and Larson (1992). Their study showed that most of the variations in world prices are transmitted, and that they constitute the dominant component of domestic prices. Harberger (1980) found that small countries with a fixed exchange rate normally inherit the process of importing world inflation. Dornbusch (1992) found that holding onto an exchange rate too long may yield an extra month of low inflation, but that such a course of action sacrifices competitiveness and thereby limits the return of growth.

The fiscal deficit is another important variable that positively affects inflation in Papua New Guinea. For most of the study period (1975–92), the budget deficit in Papua New Guinea was almost entirely financed by Australian budgetary aid. Easterly and Schmidt-Hebbel (1993) found that in countries with low to medium rates of inflation (such as Papua New Guinea), there is no relationship between long-term inflation and fiscal deficits across countries because of the different ways in which the deficit is financed (mostly through foreign aid, as in Papua New Guinea). However, financing the fiscal deficit through foreign aid sources only increases inflation (Mundlak et al. 1990).

The expansionary fiscal operations in Papua New Guinea would normally lead to a deterioration of balance of payments (rather than inflation in the short term) by increasing import-dominated private and public consumption (Meesook 1997). This must lead to imported inflation and, therefore, is

indirectly responsible for the significant relationship between the fiscal deficit and the inflation rate. Murinde (1993) undertook a macro-model simulation study of the Ugandan economy and concluded that a rise in real government spending has an anti-inflationary effect. This unusual evidence contradicts earlier findings of fiscal expansion-led inflation (Khan and Knight 1982; van Wijnbergen 1982; Snowden 1987).

Most of these conclusions are broadly in-line with the results from other developing countries such as Turkey (Lim and Papi 1997), Kenya (Durevall and Ndung'u 1998), Ghana (Sowa 1994) and Barbados (Coppin 1993).

### Forecasting (in-sample)

An in-sample forecast is made and the actual and predicted value of the dependent variable is presented in Figure 1 which indicates that the model is capable of tracking the historical value of endogenous variables with reasonable accuracy. There is a close association between the predicted and actual value of the variable. There are considerable deviations of the predictions from the actual for the periods 1985–86 and 1992–94. This is because of the serious instability and fiscal indiscipline in these periods, leading to a deteriorating external balance, depreciation of the currency and the implementation of a structural adjustment programs in 1988–92 and 1994–95. These events probably also altered the equilibrium behaviour of the variables.

The capacity of the model in out-sample forecasting must be evaluated. After the estimation period, 1975–95, there are another nine quarters from 1996 to 1998 that can be used for out-sample forecasting. Data for the important variables such as GDP and its components, fiscal operations and so on, are not available and therefore out-sample forecast could not be made.





## Policy implications

The inflation model discussed in this paper is expected to improve the technical and institutional ability to model and forecast domestic inflation, to assess the effect of instrument changes on future inflation and to understand how the monetary impulses affect the main macroeconomic variables in the economy of Papua New Guinea. The econometric analysis of the inflation model indicates the fiscal dominance, and the important role of monetary variables, including the exchange rate and import prices. Like most developing countries, an independent monetary policy in Papua New Guinea is hampered by factors such as heavy fiscal dominance, poor financial infrastructure, shallow financial markets and forms of financial repression, accommodatory monetary policy, and reliance on seigniorage. Papua New Guinea, however, has to yet to comply with the two main prerequisites for an effective IT policy framework: the central bank's scope for conducting independent monetary policy and the undisputed primacy of the inflation objective.

According to Masson et al. (1997), an IT framework could be used to conduct monetary policy in some high to middle-income developing countries but the preconditions for adopting such a framework are not yet present. They also indicated that even in developing countries with well-functioning financial markets, moderate to low inflation, and no symptoms of fiscal dominance, the scope for an independent monetary policy depends on the exchange rate regime and the extent of capital mobility. The floating exchange rate regime introduced in Papua New Guinea (since September 1994) has led the authorities to attach much more weight to exchange rate objectives and the capital mobility is almost negligible due to lack of investors' confidence in the economy.

Papua New Guinea always attempts to imitate the policies of its closest neighbour (including the IT policy of Australia and New Zealand) without preparation or creating an economic infrastructure and institutional system that will enhance the successful implementation of the policies. Until such time, Papua New Guinea should probably continue to rely on simpler and less demanding monetary policy frameworks. Masson et al. (1997) evaluated the scope for IT in developing countries and concluded that many developing countries cannot meet the technical and institutional requirements of IT and therefore 'the way to improve the monetary and inflation performance of developing countries may not be through the adoption of a framework akin to IT, at least not in the near term' (p. 3).

## Summary and conclusions

Since independence, although Papua New Guinea has not explicitly endorsed the inflation targeting policy, it continues to pursue a policy framework that enables the management of low and stable inflation. The feasibility of implementing the IT policy is evaluated and it is found that the prerequisite conditions are not satisfied and the limited technical and institutional infrastructure capacity may not permit successful implementation of the IT policy. A simple econometric model of inflation in Papua New Guinea is developed and estimated with reasonable accuracy. The model provides the basic structure and framework to study the determinants and process of inflation, and to analyse how inflation responds to macroeconomic movements in the economy. Based on the analysis, it is concluded that Papua New Guinea should probably continue to rely on a simpler and less-demanding monetary policy framework.





## Notes

- <sup>1</sup> Central Bank independence can be achieved only when: the conduct of monetary policy is not dictated or constrained by purely fiscal considerations; public-sector borrowing from the central bank and the banking system should be low or non-existent; the government should have a broad revenue base and should not rely on the revenues from seigniorage generated by excessive currency issuance; domestic financial markets should have enough depth to absorb the placement of public and private debt instruments; and the accumulation of public debt should be sustainable and not unduly constrain monetary policy (Masson et al. 1997).
- <sup>2</sup> A country that chooses a fixed exchange rate system subordinates its monetary policy to the exchange rate objective and is not effectively able to target directly any other nominal variable, such as the rate of inflation. If these restrictions are relaxed through such variants of a fixed-rate system as crawling pegs or target zones, then in theory an exchange rate target could coexist with an inflation target so long as it is clear, and central bank actions show, that the latter has priority if a conflict arises (Masson et al. 1997).
- <sup>3</sup> A macroeconomic model of Papua New Guinea that includes this inflation equation is available in Kannapiran (1998).

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