Demand for imports in Papua New Guinea

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This article explores the empirical relationship between domestic demand and imports in Papua New Guinea and evaluates the relevance of the domestic demand management policy contemplated by the IMF and the World Bank as a part of the stabilisation program in order to maintain external balance. A model of import demand is structured by applying the concept of cointegration in an error correction framework. The appropriateness of a demand management regime is evaluated. The findings support the structural adjustment programs in Papua New Guinea that emphasise a demand management approach to balance of payments focused on domestic demand.

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Papua New Guinea sustained a high level of imports in the 1970s and 1980s because of a high level of exports and the inflow of foreign aid. Without Australian budget support for the foreign exchange inflow, the balance of payments deficit was more than 80 per cent of non-mining imports (AusAID 1996). There was evidence of frequent expansion of domestic demand, without a corresponding increase in export earnings or real growth, and the increased demand was mostly satisfied by imports. This factor exerted pressure on the external balance through increased imports, and eventually a stabilisation program had to be introduced in 1994 to restore external and internal balance. A floating exchange rate regime was introduced in October 1994 and reduced to some extent, the demand for imports. Any increase in domestic demand, however, will adversely affect the balance of payments and the exchange rate through increased imports so long as imports dominate in domestic consumption (without a proportionate increase in exports). Managing the domestic demand and minimising its adverse impacts on imports and external balance has been a policy priority for Papua New Guinea.

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Specification of the model

The specification of the behavioural relationships in an import demand model depends on the formation of expectations, the lagged response of the variables involved and any structural breaks in the economy. A number of issues are considered.

- The process of expectations formation in developing countries like Papua New Guinea is quite different from processes found in the more developed world. Economic agents in developing countries may be prevented from forming rational expectations because of a lack of information and expertise. Pesaran (1987) and Fair (1984) argued against the assumption of rational expectations formation in modelling a developing economy. Accordingly, the present model is built around the simplifying assumption that expectations are naïve.
- Realistic formulations of economic models often require the inclusion of lagged explanatory variables. Economic theory cannot be expected to yield strong insights about lag structure. As suggested by Granger (1997), however, the theoretical model is specified with 'n' lag length and subsequently model selection criteria are used to identify the appropriate lag structure of the models.
- The stability of the model's parameters might have been influenced by the mineral boom after 1986; the Bougainville insurgency (from 1988) which affected export income from copper, cocoa and copra; the devaluations of the exchange rate in 1990 and 1994; and the shift from a fixed exchange rate regime to a floating exchange regime in October 1994. The data relating to the years 1975–87 and from 1987–95 are used in a Chow test to determine whether there was a structural break as a result of these events.

Traditionally, import demand has been specified as a function of real income (Dernburg 1985) and the relative prices of domestic and foreign goods. Studies by Khan (1977) specified import demand as a linear function of the level of net foreign assets and aggregate expenditure. In an open economy with a floating exchange market, imports increase as income increases, irrespective of foreign reserves. When foreign reserves are depleted, and restrictions are imposed on the supply of foreign exchange, either through exchange controls or a declining exchange rate (if market-determined), imports adjust accordingly. In Papua New Guinea, imports increase as export earnings increase by influencing income as well as the supply of foreign exchange. Net foreign assets are not a powerful variable in an open economy but under a fixed exchange rate regime it provides policymakers with an indication of the need to resort to measures to address the situation. As imports are not directly linked to exchange reserves, they are not included as a variable in the import function.

Lopez and Thomas (1990) suggested that an absorption (investment and consumption) equation, along with an import demand equation, would permit estimation of the demand for imports with the total effect of exchange rates, import prices and GDP. They also disaggregated consumption into its private and public components in order to examine the influence of the structure of total absorption (see also Aghevli and Sassanpour 1982). According to Cherry (2001), imports can be modelled as a fixed proportion of spending rather than as a function of total or disposable income. This formulation facilitates prediction of the shifts in autonomous changes in domestic spending and provides a clearer understanding of how leakages influence the multiplier process. Other authors (Boyes and Melvin 1996; Case and Fair 1999) have gone further by assuming imports (M) to be a fixed proportion of total production (Y), while others (Stiglitz 1997; Hess and Ross 1993) have another variant with imports as an increasing function of disposable income.

Cherry (2001) argued that there might be some conceptual advantage to making the link more direct between spending decisions and imports. He modeled imports as a fixed proportion of spending rather than as a function of total or disposable income.

When the exchange rate is defined as the price of a unit of domestic currency in terms of the price of foreign currency, then the exchange rate and the relative prices of domestic and foreign goods serve interchangeable functions (Dernburg 1985). An increase in either makes imports cheaper and increases demand for them. Under a fixed exchange regime, the exchange rate cannot play this role. Papua New Guinea switched over from a fixed exchange rate regime to a floating exchange rate regime from September 1994. Also, there were negligible opportunities for import substitution under consumption and investment. A preliminary estimate indicated that the exchange rate or relative price is not a significant variable and therefore it is not included as one the determinants.

Aggregate domestic demand (private and government consumption plus investment and net exports) might not be able to capture the dynamics of the real and lagged responses to various individual components. In the model specified here, real income is therefore segregated into private spending (private consumption and investment) and public spending (government consumption and investment). Total real income plus transfers and less taxes is private disposable income (Y^d). Y^d is the income available for private spending on goods and services for consumption and investment (investment being equal to saving) (Dornbusch and Fischer 1998). Taxes (plus deficit financing) are the funds available to the public sector to spend on domestic and imported goods and services and investment. Government spending (consumption plus investment = GS) is expected to affect imports with a time lag because of the procedural delay in ordering and acquiring imports for consumption and investments. Real imports are expected to be positively related to Y^d and government spending (GS) lagged by 'n' periods

$$Z_t = f\left(Y_t^d, GS_{t-n}\right)$$

where $Y_t^d\,(+), GS_{t-n}\,(+)$ (1)

Data processing, model transformation and estimation

Quarterly time-series data for the period from 1975–I to 1995–IV are used in the estimations. Most time-series variables are non-stationary, and using non-stationary variables in the model might lead to spurious regressions (Granger and Newbold 1974). The first or second differenced terms of most variables will usually be stationary (Ramanathan 1992) and, in quarterly data, the seasonal difference of a unit root process ($X_t - X_{t-4}$) may be stationary (Enders 1995). All the variables are tested at levels and in fourth-order first differences for stationarity using the augmented Dickey-Fuller (ADF) test. None of the variables are stationary at levels but are stationary in fourth-order first difference ($X_t - X_{t-4}$). Stationary variables are used in the econometric estimation of the model. Model selection tests (AIC, Schwartz, Shibata and Rice) are conducted to identify the appropriate lag structure for each model (Table 1).

The test results reveal that YD_t and GS_{t-5} is the most appropriate lag structure for the model. A linear combination of the import variables is tested for cointegration using the Dickey-Fuller cointegrating regression and Johansen trace tests (Johansen and Juselius 1990). Johansen's trace test is more efficient and provides an opportunity to evaluate multiple cointegrating vectors. These tests reveal that the linear combination is cointegrated (Table 2). The cointegrated equation is re-specified as an ECM using the Engel-Granger two step method with the lagged residual as the error correction term.

The economic model (Equation 1) is transformed into an econometric model under the ECM framework in Equation 2.

$$\Delta_4 Z_t = \alpha + \beta Y_t^d + \chi \Delta_4 GS_{t-5} + \delta EC + u_t \quad (2)$$

where EC is the error correction term (the lagged residuals of the static regression) and D_4 stands for fourth-order first differences ($X_t - X_{t-4}$). All the variables (fourth-order, first-differenced) in the equation are stationary and therefore the OLS method gives consistent and valid estimates (Enders 1995). The residuals from the regression are tested for autocorrelation error. The Lagrange multiplier test for fourth-order autocorrelation is appropriate to detect fourth-order autocorrelation in the presence of lagged dependent variables as explanatory variables (Greene 1997; Ramanathan 1992).[2] The Lagrange multiplier test confirmed the presence of autocorrelation error. In order to eliminate the autocorrelation error, the Cochrane-Orcutt (CORC) iterative method is used to re-estimate the model. A series of diagnostic tests were conducted to verify homoscedasticity, normality, specification error, structural breaks and to evaluate the predictive accuracy of the model. These tests are essential to judge the validity and acceptability of the conclusions drawn from the model estimates. The importance and relevance of these tests are discussed in Ramanathan (1992) and Gujarati (1995).

Model evaluation and diagnostic testing

The results of model estimation and the various diagnostic tests are presented in Table 3. The R-squared value is 61 per cent. The calculated F values are higher than the critical F values at the 5 per cent significance level, which indicates a significant degree of reliability of the coefficient of determination. The adjusted R-squared value suggests that there is no penalty for the number of explanatory variables used (Table 3).

The LM test for fourth-order auto-correlation revealed autocorrelated errors (not furnished in Table 3). A modified 2SLS-Cochrane-Orcutt (CORC) iterative method

Table 1 **Model selection (lag structure) test results**

Model with different lags	Rice	Shibata	Schwartz	AIC
$Z_t = f(YD_t, GS_t)$	2655.6	2618.8	3003.3	2635.7
$Z_t = f(YD_t, GS_{t-1})$	2724.5	2685.7	3083.8	2703.5
$Z_t = f(YD_t, GS_{t-2})$	2662.4	2623.2	3016.0	2641.1
$Z_t = f(YD_t, GS_{t-3})$	2713.1	2672.0	3076.0	2690.8
$Z_t = f(YD_t, GS_{t-4})$	2654.9	2613.5	3012.7	2632.4
$Z_t = f(YD_t, GS_{t-5})$	**2532.7**	**2497.6**	**2864.3**	**2513.7**
$Z_t = f(YD_t, GS_{t-6})$	2694.8	2649.9	3063.1	2670.3
$Z_t = f(YD_t, GS_{t-7})$	2855.9	2806.8	3249.1	2829.1
$Z_t = f(YD_t, GS_{t-8})$	2924.9	2872.9	3330.5	2896.5

Note: YD_{t-1} to YD_{t-8} were also tried but found to be not significant.

Table 2 **Results of cointegration: Dickey-Fuller and Johansen trace tests**

	Dickey-Fuller test with constant at 10 per cent		Johansen test with constant l_{trace} at 90 per cent			
	No trend	With trend	R_0	R_1	R_2	R_3
Imports	-2.9610	-4.2162	52.503	23.587	7.582	0.00

Notes: Asymptotic critical values at 10 per cent for the DF test are:
1 with constant and no trend -3.45 (M = 3);
2 without constant and no trend -3.84 (M = 3);
3 Johansen test critical values with constant ($l_{trace\ at\ 90\ per\ cent}$) are R_0 = 32.093 R_1 = 17.957 R_2 = 7.563

was used to estimate the autoregressive model to eliminate the autocorrelated errors. Autocorrelation is eliminated as confirmed by an analysis of the residuals.

The Bruesch-Pagan-Godfrey (BPG) test could not reject the null hypothesis of homoscedasticity but the ARCH test could not accept the null hypothesis of homoscedastic disturbance terms. The BPG test is reasonably powerful whereas the ARCH test is relevant 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 regression analysis and in moderately-sized samples as in this study. On using GLS (Generalised Least Square, to estimate the heteroscedastic models), Greene holds the view that the additional variation incorporated by the estimated variance parameters may offset the gains to GLS.

RESET results reveal that the calculated F value is less than the critical value at the five per cent significance level (Table 3). Therefore, there is no specification error in the equation.

The normality of residuals is rejected by the Jarque-Bera Lagrange multiplier test. Even if the disturbances are not normal the estimators are unbiased. This test is essentially non-constructive, and the finding of non-normality does not necessarily suggest what to do next. Further, failure to reject normality does not confirm it as it is only a test of symmetry and mesokurtosis (Greene 1997).

A Chow test was conducted to evaluate predictive stability and test for structural breaks in the model. The pre and post-mineral boom period is taken as the breakpoint for the Chow test. The results suggest that all equations are fairly stable without any structural breaks between the pre and post-mineral boom periods. The Theil inequality U value test of predictive accuracy is less than one in all cases. The model is thus reasonably accurate in prediction.

Model estimates and discussions

The parameter estimates of the model, along with the standard errors and the corresponding t-values, are given in Table 4. The signs of all estimated coefficients are as expected. The estimated parameters of variables are significant at one to 5 per cent significance levels as indicated by the t-values. The parameter of the error correction term is significant at the 1 per cent level. This result justifies use of an ECM specification of the model. The t-ratios for the private disposable income and government spending variables are significant, each at the 1 per cent level (Table 4).

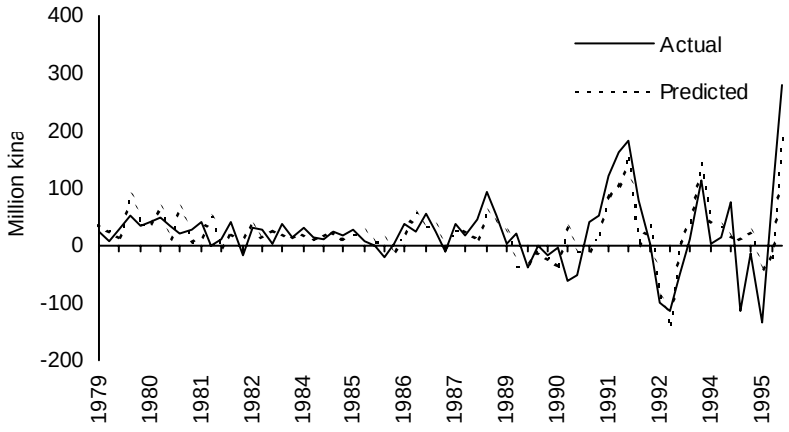
Lopez and Thomas (1990) found that government consumption has a significant

Table 3 **Results of diagnostic tests**

Details		Imports	
Model		ECM-AR(4)	
Goodness of fit		DF	
R-square		2 65	0.61
R-square (adjusted)			0.59
Test for autocorrelation: Lagrange multiplier test-Chi-square	DF=4		3.49
Tests for heteroscedasticity: Chi-square test			
BPG[3] test		3	1.12
Engle's ARCH test		1	5.38*
Specification error test (Ramsey RESET) F-test			
RESET (2)		1 63	1.88
RESET (3)		2 62	1.56
RESET (4)		3 61	2.62
Normality test -Chi-square			
Jarque-Bera LM test	DF-2		6.26*
Structural break-Chow test F-value		4 60	1.32
Predictive accuracy tests			
Mean absolute error			33.63
Root mean square error			50.95
Theil inequity coefficient U			0.818

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

Figure 1 **Actual and predicted values of changes in imports, 1979–95** (million kina)



Source: Author's estimates based on Bank of Papua New Guinea data (*Quarterly Economic Bulletin*) and the model.

Table 4 **Results of parameters estimates with standard errors and t-values**

Imports equation	Parameters	Coefficients	Standard errors	t – Value	DF=60
Constant	a	12.7680	5.683	2.25	*
Y^d_t	b	0.1415	0.0395	3.58	**
GS_{t-5}	c	0.2558	0.050	5.09	**
EC_3	d	-0.3311	0.1096	-3.02	**

Notes: * Significant at 5 per cent ** Significant at 1 per cent

impact on imports in sub-Saharan African countries. In the case of Papua New Guinea, the high level of exports and the flow of foreign aid have sustained a high level of imports. Taking away the Australian budget support from the foreign exchange flow, the balance of payments deficit must be more than 80 per cent of non-mining imports (AusAID 1996). Imports dominated private and public spending on consumption and the foreign component of investment. The present finding is in line with an earlier study of trade balance issues in Iran by Aghevli and Sassanpour (1982) that found imports to be a function of public and private expenditure. There were several occasions when the government funding for imports was held in a trust account and utilised after a time lag of three to five quarters. Government spending (consumption and investment) therefore affects imports with a minimum lag of five quarters because of the procedural delay in ordering and acquiring imports.

Conclusions and policy implications

Several conclusions can be drawn from this study of the demand for imports using an ECM. First, the ECM of imports is appropriate and provides an appropriate framework in which to study the relationship between imports and its determinants. Second, the findings concur with many earlier studies that the determinants of imports are private and government spending (see Cherry 2001; Lopez and Thomas 1990; Aghevli and Sassanpour 1982). Third, as evidenced by the cointegration, this is a long-term equilibrium relationship. Finally, from the economic policy perspective, a domestic demand management regime is appropriate. Given the current floating exchange rate regime, it can be concluded that the domestic demand management policy in Papua New Guinea must be targeted to maintain external balance and a stable exchange rate.

The study provides evidence that fiscal expansion leads to external instability while fiscal contraction improves the external balance by reducing imports with an elasticity of 0.26 of import demand to government spending. One of the agenda items for reform under the program is managing domestic demand in order to maintain external balance. This finding supports the structural adjustment programs in Papua New Guinea that have emphasised a demand management approach to balance of payments focused on domestic demand (private and public spending). A prudent fiscal policy of public expenditure reduction and balancing national budgets would have a direct impact on the level of imports and indirectly on the external balance.

Note

[1] In quarterly time-series data, there is a likelihood of fourth-order autocorrelation (Ramanathan 1992).

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