

Economic growth in Papua New Guinea: some empirical evidence

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In 'Economic growth in Papua New Guinea: some empirical evidence' (*Pacific Economic Bulletin*, 12(1) 1997) Azmat Gani presents some preliminary econometric analysis of the determinants of growth in Papua New Guinea. As Gani notes, the policy debate in Papua New Guinea is conducted largely independent of rigorous quantitative analysis—at least at the macroeconomic level. This fact is somewhat disconcerting but is probably more a reflection of data quality and availability than any conscious neglect.

Any econometric investigation of the determinants of growth in Papua New Guinea is limited by the short time frame over which necessary data is available. With most growth data only available at annual intervals the maximum number of observations available to the researcher is approximately 20; less if more nuanced modeling structures are used.

Furthermore, the large informal sector of the economy poses problems for accurate estimation of GDP. Therefore, GDP and other macro-indicator estimates are likely subject to a significant degree of error.

Despite these reservations, statistical analysis of the PNG economy may have

some value. While coefficient estimates are likely to be of little value beyond the level of confirming the relevant order of magnitude, they can confirm or dispute existing back-of-the-envelope calculations made by researchers and policymakers. However, for econometric analysis to inform the policy debate it must be rigorous and, in particular, take into account the unique structural features of the PNG economy. The framework employed by Gani while a useful starting point, has a number of significant shortcomings which may lead to confusion over the relative importance of the various sources of growth in Papua New Guinea. This paper highlights some potential problems with the estimates and presents results from an alternatively specified model.

Some methodological issues

Econometric analysis is always subject to specification and methodologically based criticism. While Gani's vector of independent variables is relatively non-controversial, the specification of the variables is problematic in several important respects.

The investment ratio

Perhaps the most disconcerting implication of the estimates presented by Gani is the statistical insignificance of investment, both in physical and human capital, in driving growth in Papua New Guinea. Virtually all growth theory suggests a significant link between capital accumulation (both physical and human) and growth. Furthermore, the importance of the accumulation mechanism is confirmed by the empirical literature and may even be the dominant engine of growth in many developing countries, from East Asia (Young 1993) to Latin America (Elias 1990).

The core of the problem, however, lies in Gani's mis-specification of the physical and human capital variables. A standard neo-classical growth accounting framework begins with the following identity

$$\dot{y} = \alpha \dot{l} + (1 - \alpha) \dot{k} + \theta \quad (1)$$

Where y , l , and k are output, labor and capital and $\dot{}$ indicates the time derivative or growth rate form. The final term, θ , is total factor productivity (TFP) and can be empirically proxied by a vector of variables that capture economic policy and other environmental factors.

Equation 1 cannot be calculated directly for most developing countries as the required labor and capital shares of output, α and $1 - \alpha$ respectively, are generally unavailable. Furthermore, accurate capital stock estimates are also often difficult to acquire, as is the case for Papua New Guinea. Given these constraints, some economists (such as De Gregorio 1992) suggest substituting iY/K , where i is the investment to output ratio, for k in Equation 1 and then estimating the implicit factor shares α_i and $1 - \alpha_i$

$$\dot{y} = \theta + \beta_1 \dot{l}_i + \beta_2 \dot{k}_i + u_i \quad (2)$$

Under the specification of Equation 2 the coefficient on capital, β_2 , equals $(1 - \alpha_i)Y/K$ as opposed to the factor share itself as in Equation 1.

Equation 2 implies that the appropriate proxy for the growth rate of capital accumulation is the investment ratio. Gani, however, uses the 'percentage change in the real annual gross domestic investment/GDP ratio' as opposed to the ratio itself. This specification is more akin to the rate of acceleration of capital accumulation as opposed to the rate of capital accumulation. While such a variable may be related to growth, it would be in a model of non neo-classical origin. Gani makes an identical error in his specification of the human capital parameter.

Government consumption

A similar problem exists in the specification of Gani's government consumption parameter. In terms of growth, the relative variable is the magnitude of government consumption relative to output, not the rate of growth of this ratio (Barro and Sala-i-Martin 1995). This problem is corrected in the results presented here.

External disturbances

For a mineral-fuel export-dependent economy like Papua New Guinea the change in the terms-of-trade is probably a better proxy for external shocks than the growth rate of the OECD economies. Commodity prices often move counter-cyclically to the business cycles of the Northern Economies (as was the case in the OPEC oil shocks). The terms-of-trade is also more standard in the literature (Barro and Sala-i-Martin 1995).

Accounting for Papua New Guinea's unique economic structure

Papua New Guinea is a dual economy, with a highly modern and capital-intensive production structure existing within the context of a larger subsistence economy. These two sectors of the economy have minimal linkages between them. Furthermore, through the mechanism of the Dutch Disease, their patterns of expansion and contraction may be negatively related (Sachs and Warner 1995, Graham 1997). Therefore, to aggregate negatively related variables (mining and non-mining GDP) and model them as a function of a common set of parameters may be problematic.

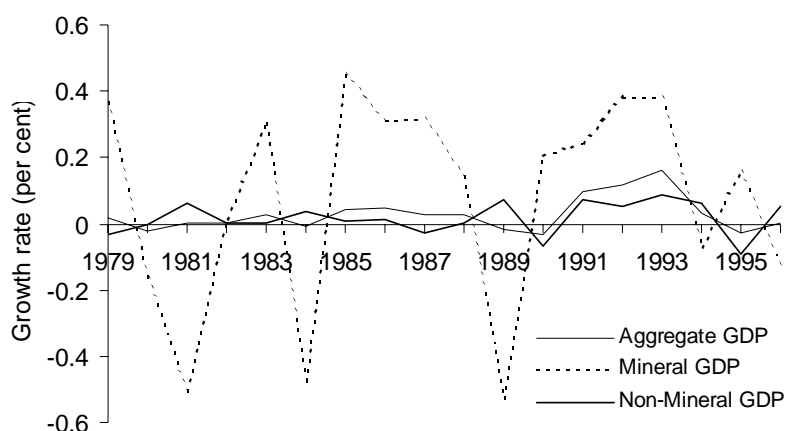
Figures 1 and 2 confirm that Papua New Guinea suffers from the Dutch Disease. Figure 1 shows the growth profile for aggregate GDP and for mineral and non-mineral GDP separately. A clear counter-cyclical trend can be observed between mineral and non-mineral GDP.

Figure 2 statistically confirms the negative relationship. Over the post-independence period for which there is data, there is a clear and statistically significant negative relationship between non-mineral and mineral GDP.

In order to account for this structural feature of the PNG economy, aggregate GDP is replaced with non-mineral GDP as the dependent variable, and mineral GDP is included as an independent variable.

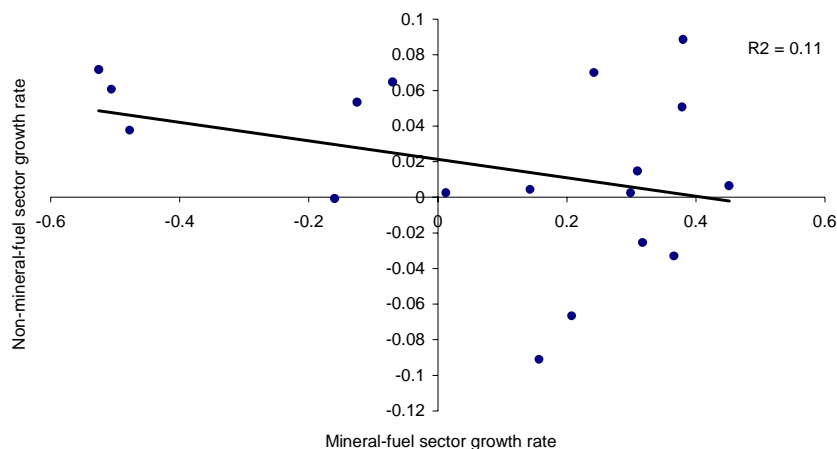
A second consequence of this unique structure relates to the investment ratio. Many authors, arguing that there is a qualitative difference between public and private investment, enter the two variables into growth models separately. This argument is especially valid for Papua New Guinea for two reasons. First, private investment is dominated by investment in the mineral sector. The mineral sector, where a significant portion of the economic returns to investment is economic rent, is likely to

Figure 1 Growth of the Papua New Guinea economy, 1979–96



Sources: World Bank (various issues), *World Tables*, World Bank, Washington, DC; South Pacific Social and Economic Database, National Centre for Development Studies, The Australian National University, Canberra.

Figure 2 'Dutch disease' effects in Papua New Guinea, 1979–96



Sources: World Bank (various issues), *World Tables*, World Bank, Washington, DC; South Pacific Social and Economic Database, National Centre for Development Studies, The Australian National University, Canberra.

have a different rate of return to investment than the public sector. Second, the institutional and political pressures under which investment takes place are likely to be different between the public and private sectors. In the estimates below public and private investment are entered into the model separately.

A new set of econometric estimates

Table 1 reports maximum likelihood (to account for serial correlation) results for growth in Papua New Guinea from 1980 to 1995; the years for which all relevant data are available.

The results are note-worthy for several reasons. First, public and private investment as well as investment in human capital (as proxied by the primary school enrollment rate) are all positively and significantly related to growth. This conforms to theoretical expectations. Most

promising perhaps is the strong correlation between education and growth, suggesting that the government should continue to focus on the expansion of coverage and improvement of quality in primary education. With current enrollment averaging just over 10 percent of the school age population the expansion of educational opportunities and coverage represent a potentially huge source of growth in the near future.

The growth of the mineral sector adversely affects growth in the rest of the economy (Figure 2). Dutch Disease effects have long been suggested as a reason for Papua New Guinea's stagnant economic performance. The results presented above lend some credibility to this view. The growth rate of the mineral-fuel sector averaged about 9 per cent a year over the sample period. This growth rate corresponds to a 0.7 per cent reduction in

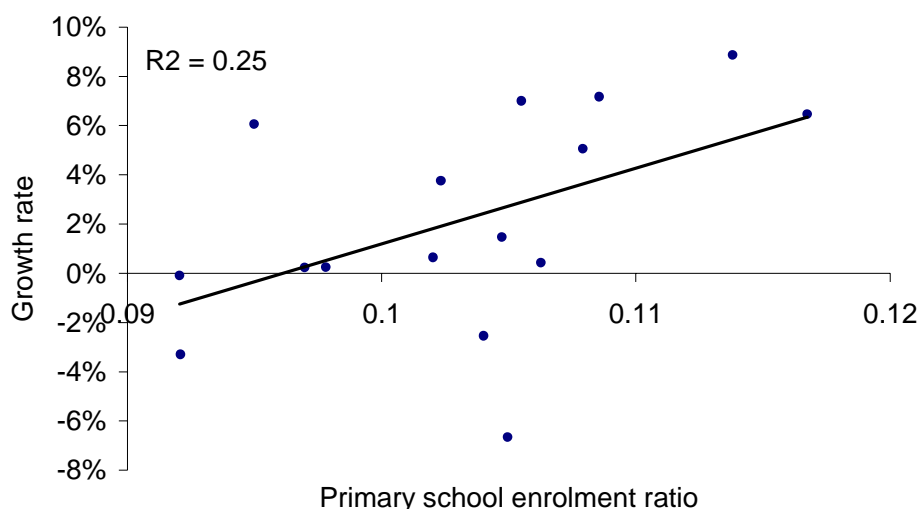
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Table 1 Maximum likelihood iterative technique growth rate estimates

	Growth _{Non-Mining}	Comments	Growth _{Mining}	Comments
Intercept	-1.61 (6.81)**		0.04 (0.85)	
Growth _{POP}	26.38 (1.86)@	p-value of 0.063	69.39 (0.35)	
I _{PRIVATE} /Y	0.40 (2.11)*		-12.72 (0.78)	
I _{PUBLIC} /Y	2.38 (2.36)*		-1.46 (0.41)	
Primary school enrolment rate	6.16 (2.30)*		-26.58 (0.70)	
Growth _{Mining}	-0.08 (3.80)**		-	
G/Y	0.88 (2.31)*		9.06 (1.54)	
Inflation rate	-1.24 (2.19)*		10.02 (1.18)	
TOT growth	0.33 (4.04)**		2.36 (2.33)*	
Real exchange rate change	0.21 (1.92)@	p-value of 0.055	2.44 (1.90)@	p-value of 0.057
Number of observations				
(F-statistic)	15 (12.6)**		15 (1.92)	
R ² adj-R ²	0.96 0.88		0.72 0.34	
dw-statistic (original)	3.31		2.77	

Note: A *, **, and @ symbol next to the t-statistic indicates a significance level of 0.01, 0.05, and 0.10 for the corresponding coefficients respectively.

Figure 3 Primary school enrolments and growth in the non-mineral fuel sector



Sources: World Bank (various issues), *World Tables*, World Bank, Washington, DC; South Pacific Social and Economic Database, National Centre for Development Studies, The Australian National University, Canberra.

the growth rate of the non mineral-fuel sector. The mineral sector may also have a secondary adverse impact on growth through the real exchange rate. The Dutch Disease places upward pressure on the exchange rate; this, in turn, adversely affects competitiveness in the non-mineral sector of the economy (Duncan et al. 1998). Regardless, the direct impact of the Dutch Disease on Papua New Guinea's growth performance is large enough to be of some concern. It is not large enough however, to condemn Papua New Guinea to stagnant growth indefinitely.

Government consumption positively and significantly affects economic growth. This result is in contradiction to Gani's finding of a strong negative correlation between government consumption and growth, a finding which also finds strong support in the cross-country literature (Barro and Sala-i-Martin 1995). The results presented above probably represents the dominance of the aggregate demand effects of government spending over the distortionary effects once a vector of other factors is properly accounted for.

Inflation, as in Gani's results, adversely affects economic growth—price stability should be and is an important macro-policy goal. More interesting however is the positive relationship between the real exchange rate and economic growth. This result suggests that a depreciation of the exchange rate accelerates growth while appreciation dampens growth. This finding is consistent with other results reported in a forthcoming study on exchange rate policy in Papua New Guinea by Duncan et al. (1998). The positive relationship between depreciation and growth suggests that the kina has been overvalued for much of the post-independence period, possibly because the indexation of wages with inflation locked real wages at a level which

was too high.

Finally, as expected, an increase in the terms-of-trade has a positive effect on economic growth. This result confirms that Papua New Guinea's non-mineral sector is externally exposed. However, the impact is not large relative to the investment and other macro-policy variables.

The value for R^2 of 0.96 indicates that the model adequately highlights those factors critical for growth in Papua New Guinea. Furthermore, the explanatory power of the model represents a significant improvement over the model presented by Gani.

Table 1 also reports results for an estimation of the determinants of growth in the mining sector. Significantly, none of the independent variables has a significant impact on mining output except the terms-of-trade. This is a reflection of two things. First, a significant share of mining output is economic rent. The size of these receipts is largely a function of non-economic factors (for example, ore quality). Second, the sector is entirely export-oriented and therefore is highly exposed to external shocks; hence the overwhelming importance of the terms-of-trade in determining output levels. However, with an adjusted- R^2 value of only 0.34 there are clearly other factors affecting mineral output. The divergence in the explanatory power of the model for non-mineral and mineral GDP confirms that the two variables should be modeled independently.

Conclusion

It would be dangerous to view any macroeconomic estimates from PNG data as absolutely accurate. However, the results presented above do give an idea of the order of magnitude of the some of the key factors affecting economic growth and performance in Papua New Guinea.

C o m m e n t

The results are somewhat conventional—investment in physical and human capital, price stability, a competitive exchange rate, and a favorable terms-of-trade promote growth.

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Appendix

Data sources

Variable	Description and Source
Growth _{Non-Mining}	The growth rate of non-mining GDP. Calculated from World Bank, <i>World Tables</i> and South Pacific Economic and Social Database, National Centre for Development Studies, The Australian National University, Canberra.
Growth _{POP}	The growth rate of the population, this serves as an imperfect proxy for the growth rate of the labor force (World Bank, <i>World Tables</i>).
I _{PRIVATE} /Y	The ratio of private investment to GDP (World Bank, <i>World Tables</i>).
I _{PUBLIC} /Y	The ratio of public investment to GDP (World Bank, <i>World Tables</i>).
Primary school enrolment rate	The primary school (South Pacific Economic and Social Database, National Centre for Development Studies, The Australian National University, Canberra)

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Growth _{Mining}	The growth rate of mining (mineral and oil) GDP. Calculated from World Bank, <i>World Tables</i> and South Pacific Economic and Social Database, National Centre for Development Studies, The Australian National University, Canberra.
G/Y	The ratio of government consumption to GDP (World Bank, <i>World Tables</i>)
Inflation rate	The inflation rate as calculated from the CPI (World Bank, <i>World Tables</i>)
TOT growth	The growth rate of the terms-of-trade (World Bank, <i>World Tables</i>)
Real exchange rate change	The real effective exchange rate as reported in International Monetary Fund <i>International Financial Statistics</i> .