MEASURES OF POTENTIAL OUTPUT IN FIJI

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Abstract

Measures of potential output and the output gap are useful to help identify the scope for sustainable non-inflationary growth and to allow for an assessment of the stance of macroeconomic policies. This paper reviews four methods that can be used to estimate potential output and the output gap, including linear trends, Hodrick-Prescott (HP) filters, aggregate production functions, and structural vector autoregressions. The paper estimates potential output and output gaps using each of the four methods and compares the properties of the different estimates. The results suggest that the output gap is measured very imprecisely in Fiji and is dominated by supply induced fluctuations in output, and hence has very different implications for policy-makers than in the more usual demand-induced case.

1.0 Introduction

This paper examines a variety of methods that can be used to estimate a country's potential output and presents empirical estimates for Fiji. Potential output can be thought of as the maximum output an economy can sustain without a rise in inflation. If actual output is below potential, resources are not being fully utilised and this puts downward pressure on inflation. If actual output is above potential this can be seen as a source for inflationary pressures and as a signal for the central bank to tighten monetary policy.

Once potential output is estimated, the output gap can be constructed as actual output less potential output. The output gap corresponds to the transitory component of output. The output gap provides information about excess or deficit capacity in an economy at a point in time and it can be included in price and wage models to provide more accurate forecasts.

Section 2 examines four techniques used to estimate potential output and the output gap. The methods include linear time trends, Hodrick-Prescott (HP) filters, an aggregate production function model and a structural vector autoregression model. Section 3 presents the empirical results for Fiji using each of the four different methods. The results are examined to determine the most suitable and realistic for use in Fiji's case. We also estimate a series of Phillips Curve equations using the output gaps constructed by each of the four methods. The predictive power of the gaps with respect to inflation is examined. Section 4 concludes the paper.

2.0 Methodologies Used to Estimate Potential Output

This section describes the four methods that are used to estimate potential output. The results are presented in Section 3.0

2.1 Linear Trend Method

The simplest method to calculate potential output is a linear trend. This method is favoured in some empirical work because it is easy to construct and straight-forward to interpret. The linear equation is:

$$Y_t^* = \alpha + \beta\tau \qquad (1)$$

where Y* is potential output, α is the intercept, β is the coefficient for the slope or the trend of potential output and τ is a time trend.

Criticism of this method arises from the fact that it is a-theoretical. That is, it is a simple statistical procedure that does not rely on economic theory. The growth of potential output is linked to the growth of labour productivity and labour inputs, which in turn is linked to changes in the population and labour force participation. There are no convincing reasons that these components are constant over time especially if a country has undergone structural reforms. In Fiji's case, there have been coups, natural disasters and massive loss of skilled labour due to emigration over the last 13 years. Therefore, a more flexible approach is needed to obtain better estimates of potential output.

The main assumption of this method, that potential output grows at a constant rate, is not practical in real life. Also, the sample period chosen can distort the results (de Brouwer 1998). The estimate of the output gap depends on the selection of the starting and end-points of the sample. The fact that the output gap estimates are sensitive to the sample period also undermines the credibility of the estimates obtained from this linear trend method.

2.2 The Hodrick-Prescott filter

The Hodrick-Prescott (HP) filter is a popular method by which to extract a trend from macroeconomic data such as output. The HP filter can be used to extract trend or potential output, from actual output data. This technique minimises a combination of the size of the actual output fluctuations around its trend and the rate of change in the trend output for the whole sample. Potential output in the HP filter is the series of values that minimises the expression:

$$\sum_{t=1}^{T}(Y_t - Y_t^*)^2 + \lambda\sum_{t=2}^{T}\left[(Y_{t+1}^* - Y_t^*) - (Y_t^* - Y_{t-1}^*)\right]^2 \quad (2)$$

where Y and Y^* are actual and potential output respectively and λ is a weighting factor that determines the degree of smoothness of the trend (Cerra and Saxena 2000). Typically this is set to λ=1600 for quarterly data and λ=100 for annual data, which has the effect of removing those cycles with frequencies shorter than eight years from the data. This choice comes from the business cycle work of Burns and Mitchell (1944), who found that the length of business cycles in the United States varied between two and eight years. Changing the weight affects the responsiveness of potential output to movements in actual output.

The advantage of the HP filter is that it renders the output gap stationary over a wide range of smoothing values (Hodrick and Prescott 1997) and it allows the trend to change over time.

The HP filter has several shortcomings, including the arbitrary choices of the business cycle frequency and the smoothing parameter λ, the neglect of structural breaks and regime shifts and the inadequate treatment of nonstationary dynamics (Scacciavillani and Swagel 1999). The properties and shortcomings of the HP filter have been well documented by Harvey and Jaeger (1993), with further discussions on specific shortcomings by Barrell and Sefton (1995) and Coe and McDermott (1997).

2.3 Aggregate Production Function

Another method that can be used to estimate potential output is an aggregate production function. This is a structural approach derived from the Cobb-Douglas specification and can be characterised as:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} \quad (3)$$

where Y is output, which depends on the level of total factor productivity (also referred to as the level of technology), A, the labour force, L and the capital stock, K. The parameter α is the share of capital income whilst β is the share of labour income ($\beta = 1-\alpha$). The level of productivity cannot be measured directly, but can be estimated using historical data on labour and capital and factor shares. The level of productivity A can be calculated as:

$$A_t = Y_t / (K_t^{\alpha} L_t^{\beta})$$ [1]

A trend is then fitted to the level of productivity, A_t, to estimate a trend of productivity that can be used to calculate the potential output. Potential output is then estimated using the trend estimate of the total factor productivity together with the labour force L, and the stock of capital K. This method has a stronger theoretical basis compared with the linear and HP filter methods.

The main criticisms of the production function approach are that there are a range of assumptions that have to be made about potential labour and capital and the data on capital stock are not accurate (as in Fiji's case). The method also uses simple detrending procedures like in the HP filter, which has a significant bearing on the gap estimate.

Even though these criticisms are valid, most of them also apply to other methods. However, the production function can be followed

[1] α= 0.47 and β=0.53, in the case of Fiji. This estimated that the total factor productivity for Fiji has been growing about 1 percent a year since 1970

intuitively and is widely used (Giorno et al. 1995; De Masi 1997).

2.4 Structural Vector Autoregression

The fourth method used to estimate the potential output is called a structural vector autoregression (SVAR). This method blends economic theory with statistical techniques to distinguish between permanent and temporary movements in output. Structural VAR is a technique for recovering structural shocks from reduced form residuals. The structural shocks are divided into demand and supply shocks, using a variety of identification techniques. The effects of demand shocks on output are regarded as temporary and the aggregate supply shocks as permanent. Potential output is constructed by aggregating successions of supply shocks; the output gap is an aggregation of the demand shocks on output. This method has a stronger reliance on theory but at the same time allows the data to determine the short-run dynamics.

3.0 Empirical Results

The four measures of the output gap were constructed for Fiji using the techniques described in Section 2. The results are shown in Figure 1 and the summary statistics are shown in Table 1.

Looking at Figure 1, the graph shows that each method produces a different result for the output gap. The volatility is different between the methods, with the linear method[2] being the most volatile and the SVAR method the least. The magnitude of the volatility also varies between the four methods with the linear method having the highest magnitude and SVAR method having the least magnitude. The turning points for the linear method and the HP method look similar while the other two methods have different turning points.

The summary statistics in Table 1 show a breakdown of the results from all the four methods used. Firstly, the correlation coefficient shows how closely the results from each method are related to each other. The closest correlation looks to be between the linear method and the HP method, while both the SVAR and APF method seem to be the least correlated with the linear method. The APF and SVAR are also poorly correlated.

The poor correlation of the different gap measures raises questions about the suitability of using any one measure to assess the extent of excess or deficit capacity in the economy. Since the different measures point to different turning points and different degrees of slack in the economy, they also signal the need for substantially different policy responses, both in terms of the timing and magnitude of policy changes.

To assess the usefulness of the output gap measures constructed using the four techniques, each of the output gap terms was used in a simple Phillips curve equation to help predict inflation. The Phillips curve

[2] The linear method resulted in the equation: $Y_t^* = 6.58 + 0.0229\text{trend} + 0.2142\text{dummy}$, which shows a growth of about 2.3 percent a year in potential output over the last 33 years.

equation is:

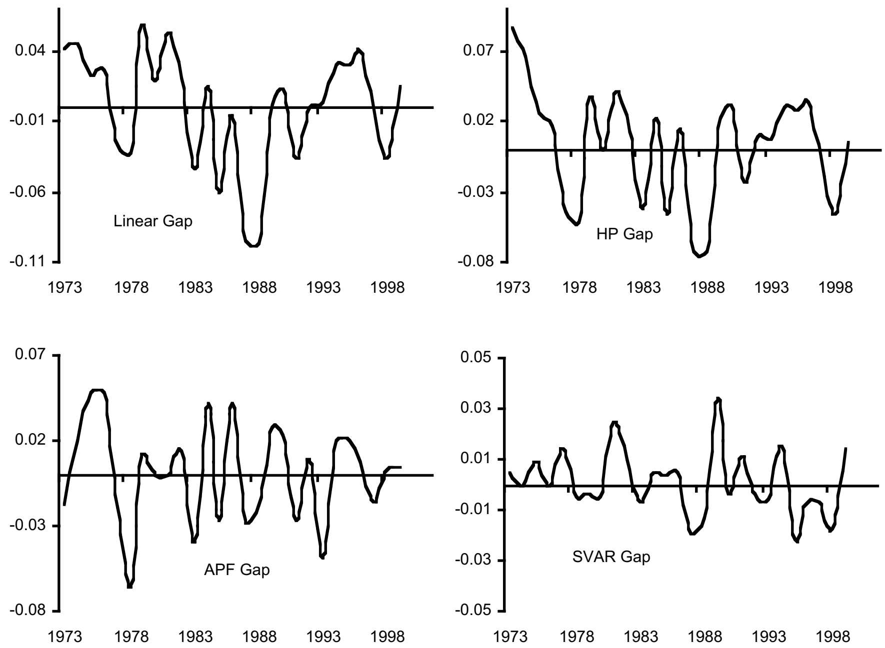
$$\pi_t = \beta\pi_{t-1} + \alpha(Y^* - Y)_t \tag{4}$$

where π is the change in the log of CPI, and α is the coefficient for each of the output gaps used in the equation.

Traditionally, the sign on α is expected to be positive with demand-induced fluctuations in output associated with higher inflation over time. It is possible, however, that fluctuations in output in developing countries like Fiji reflect supply shocks rather than the usual demand shocks. In this case the sign on α will be negative, with temporary rises in output (due for example to favourable supply shocks – such as an oil price fall) associated with lower inflation.

The results from the Phillips curve tests are shown in Table 2, with the results using the lagged output gaps shown in Table 3.

FIGURE 1
Output Gaps



The results for the linear method show that the output gap is not significant at the 5 percent level. This means that the information derived from this method will not predict inflation with any accuracy. However, the lagged output gap is significant at the 10 percent level suggesting that there may be some predictive power in the results.

For the HP trend method, the results show that the output gap is not significant at the 5 percent level. This suggests there is very little information in the measure, as constructed, for predicting inflation. The lagged output gap was also not significant at the 5 percent level.

The production function method results are significant at the 10 percent level but the coefficient has a negative sign. This suggests that this method is sensitive to supply shocks and not demand shocks, which are dominant in developed countries. The lagged variable was not significant at all.

Table 1: *Summary Statistics*

Correlation Coefficient

	Linear	**HP Filter**	**APF**	**SVAR**
Linear	1			
HP Filter	0.73	1		
APF	0.10	0.42	1	
SVAR	0.11	0.32	0.18	1

Descriptive Statistics

	Linear	**HP Filter**	**APF**	**SVAR**
Max.	0.160	0.087	0.084	0.034
Min.	-0.097	-0.073	-0.072	-0.022
Std.Dev	0.054	0.039	0.036	0.012

	Linear	**HP Filter**	**APF**	**SVAR**
Turning Pts.	17	19	17	22

Table 2: *Results of Phillips Curve Equation*

Dependent Variable: Inflation; Estimation Period 1971-1999

	Linear Gap	**HP Gap**	**APF Gap**	**SVAR Gap**
Lagged Inflation	0.9221**	0.9368**	0.9350**	1.0188**
	(0.0682)	(0.0680)	(0.0623)	(0.0471)
Output Gap	0.0134	-0.0101	-0.0691	-0.4475**
	(0.0265)	(0.0362)	(0.0390)	(0.0790)
Summary Statistics				
$\bar{R}^2$	0.5507	0.5477	0.5935	0.7926
Durbin Watson	1.9208	1.7690	1.8623	1.007

Note: Standard Errors in parenthesis. *(**) denotes significance at the 5(1) percent level.

The results for the last method suggest that the SVAR output gap is significant at the 5 percent level but the coefficient has a negative sign. The lagged variable is not significant at either the 5 or 10 percent level.

The sign of the coefficients in the Phillips Curve equation is very important as it tells us whether the output gap is due to demand side or supply side pressures. In industrialised countries, the sign of the coefficient is positive suggesting demand side shocks dominate fluctuations in actual output around potential. But in developing countries a negative sign might be more appropriate as these countries are more vulnerable to supply side shocks such as natural disasters, coups, political disturbances and so on.

Since the more sophisticated measures of the output gap produce measures that behave like supply shocks in price adjustment equations, there is a need for caution in how the measures are applied when formulating policy and in macroeconomic modelling. The traditional demand-induced fluctuations and subsequent profiles of price adjustment may be a poor reflection of what happens in practice in developing countries like Fiji.

Table 3: *Results of Phillips Curve Equation*

Dependent Variable: Inflation; Estimation Period 1971-1999

	Linear Gap(-1)	**HP Gap (-1)**	**APF Gap(-1)**	**SVAR Gap(-1)**
Lagged Inflation	0.8939**	0.9156**	0.9315**	0.933**
	(0.0653)	(0.0662)	(0.0657)	(0.0655)
Output Gap(-1)	0.0455	0.0376	-0.0104	-0.0573
	(0.0246)	(0.0352)	(0.0372)	(0.1110)
Summary Statistics				
$\bar{R}^2$	0.5973	0.5648	0.5477	0.5509
Durbin Watson	1.827	1.6802	1.8726	1.9601

Note: Standard Errors in parenthesis. *(**) denotes significance at the 5(1) percent level.

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4.0 Conclusion

Potential output and the output gap play an important role in macroeconomic modelling and policy formulation. If there is excess capacity in the economy then more can be produced and thus more jobs can be created without inducing inflationary pressures. A deficient capacity on the other hand can generate increased price and wage pressures.

This paper reviewed four methods used to estimate potential output and from that the output gap – linear time trends, Hodrick Prescott (HP) filters trends, production function and the structural vector autoregression method. The results suggest that measures of the output gap are very imprecise and can give very different indications of the degree of slack in the economy.

The results also suggest that the output gap is a relatively poor predictor of inflation in Fiji, at least within the simple framework of a Phillips curve relationship.

The use of more sophisticated structural techniques - the production function and the SVAR - to construct the output gap, yields measures with more predictive power. The signs suggest that the fluctuations in output are largely due to supply shocks rather than the demand-induced fluctuations more common in developed countries. This tends to be in line with expectations for Fiji, which is prone to supply-side shocks. These types of gaps are associated with very different types of price adjustment processes compared with the usual models.

Overall the results suggest considerable caution should be used when constructing output gaps and using them for policy analysis in developing countries such as Fiji.

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