

Estimates of output gaps in four Southeast Asian countries

Carlos C. Bautista

Abstract

The output gaps derived for four countries using a generalized Hamilton model are compared with conventional output gap estimates. Further research is needed to explain why the output gap identifies crisis episodes as slowdowns instead of recessions in some countries.

Keywords: Asian crisis, generalized Hamilton, Markov regime-switching, output gap, stochastic trend

JEL classification: E32

November 2002

Correspondence:

Carlos C. Bautista
College of Business Administration,
University of the Philippines
Diliman, Quezon City, Philippines

Tel No: (632) 928-4571 to 75
Fax No: (632) 920-7990
E-mail: bautista@up.edu.ph
Web: www.up.edu.ph/~cba/bautista

Estimates of output gaps in four Southeast Asian countries

1 Output gap measurement

The output gap, defined as the excess of actual output over potential output, is one of the main components of models of price determination based on the Phillips Curve and is often used as an argument in monetary policy reaction functions (see for example, Roberts, 1995 and Clarida et al, 2000). However, estimates of the output gap are difficult to obtain because potential output is not directly observable. Indeed, some less than satisfactory empirical results obtained for the US economy using such estimates are a reflection of these difficulties. Because of this problem, several methods have been proposed to obtain reasonable estimates of potential output.

One of the earliest (and simplest) methods of arriving at potential output is through a decomposition of output data into cyclical and deterministic linear trend components using OLS. The latter is taken as a measure of potential output. The trend can also be specified as linear-quadratic to capture breaks in an otherwise smooth linear trend. By construction, potential output derived from these methods is unaffected by shocks. This is seen as the main limitation of these methods. The Hodrick-Prescott filter is another useful method that also allows trend growth to vary over time and has been extensively used by researchers. Kuttner (1994), following Watson (1986) and Clark (1989), shows that potential output and the Phillips curve can be estimated simultaneously using a bivariate unobserved components model. Here, potential output is the stochastic trend and shocks to it partly explain economic fluctuations.

This study measures the output gap of four Southeast Asian economies, Indonesia, Malaysia, Philippines and Thailand, by estimating potential output as a stochastic trend using a generalized Hamilton model due to Lam (1990). Because the model uses Markov regime-switching techniques, it has the advantage of accomplishing the task of accounting for both shocks to

potential output and breaks from trend that lead to unusually large negative growth like the one caused by the 1997 Asian crisis. The study also reports the estimation results of backward-looking Phillips curve equations for each country using these output gaps and those derived from a deterministic trend.

2 The generalized Hamilton model

Hamilton (1989) shows a method to analyze economic fluctuations as the outcome of switches from one state to another, with the change in state being governed by an unobserved first-order Markov process. In this method, the series of interest is assumed to contain a unit root and all shocks to the series are permanent. Lam (1990) extends the original Hamilton model to enable the modeling of processes whose autoregressive component need not have a unit root. Let q_t be the variable of interest, which in this study is the log of real GDP. This can be decomposed into its trend, x_t , and cycle, z_t which is the measure of the output gap:

$$q_t = x_t + z_t \quad (1)$$

$$x_t = x_{t-1} + \mu_0 + \mu_1 s_t \quad \mu_1 > 0 \quad (2)$$

$$\phi(L)z_t = \varepsilon_t \quad \varepsilon_t \sim N(0, \sigma^2) \quad (3)$$

The trend component shown in (2) is a random walk with a drift that evolves according to a two-state Markov process. The binary variable s_t represents either a high or a low growth state of the economy in period t . The probability that state j follows state i is given by the transition probabilities, $p_{ij} = Pr(s_t = j | s_{t-1} = i)$ where $\sum_j p_{ij} = 1$ and $i, j = 0, 1$. In (3), notice that if one of the roots of $\phi(L) = 0$ is unity, x_t and z_t are not identified and the model collapses to the original Hamilton model. As in most studies that attempt this kind of decomposition, the cyclical component in this study is assumed to be driven by a second-order autoregressive process to cover a wide array of possible dynamics.

Kim (1994) reworks Lam's specification using state space techniques. In this case, (1) is the measurement equation and (2) and (3) are the transition equations. The flexibility of state space modeling allows him to devise a solution to the model based on an approximation method. He shows that his smoothing algorithm, the one used by this study, yields approximate maximum likelihood estimates that are very close to Lam's exact maximum likelihood estimates. As in Lam, the algorithm has as one of its outputs, the probability of occurrence of a state for each period given information up to the end of the sample and is also known as the smoothed probability. Because information before and after an observation is realized are used, a "two-sided" output gap is derived. The advantage of the algorithm is in ease of use and savings in terms of computing time. Further details on the solution technique and programs are in Kim and Nelson (1999).

3 Data and estimation results

The quarterly real GDP data in domestic currency terms used in this study were derived from various sources. Deseasonalized real GDP of Thailand and the Philippines were obtained from the Asian Development Bank's (ADB) Asia recovery information center (ARIC) website. Real GDP of Malaysia was retrieved from various issues of the International Financial Statistics yearbook, while real GDP of Indonesia was obtained from the website of its central statistics bureau, *Biro Pusat Statistik* and the ADB ARIC website. Malaysian and Indonesian GDP level data exhibited strong seasonality and were deseasonalized using the Census X11 procedure prior to use. The price levels used were the CPIs of the respective countries and were all obtained also from the ADB ARIC website.¹

¹ The website addresses are aric.adb.org and www.bps.go.id/index.shtml. Phillips-Perron unit root tests indicate that both CPI and GDP log levels for all countries in the study are difference stationary but are not shown here due to space constraints.

Table 1 shows the results of estimation of the generalized Hamilton model. As can be seen from the Table, all parameters are statistically significant except for some estimates of ϕ_2 . This may be due to the relatively small sample sizes used in the estimation. The sum of the ϕ parameters for all countries is less than unity and no explosive cycles are seen.

Figure 1 shows the estimates of the smoothed probability of a low growth state for the four countries. One can see from the diagrams that the model can distinguish high and low growth states very well. The effects of the 1997 Asian crisis of varying degrees are clearly seen in these diagrams. It covers the third quarter of 1997 to the third quarter of 1998. The relatively low 0.44 percent annual growth posted by Malaysia in 2001 due mainly to poor export performance, is also captured by the model. The Philippine fiscal crisis of 1990 that was made worse by the power crisis of 1992 is also shown in the diagram. These low growth dates for the Philippines fall within previous estimates of recession dates used in Bautista (2002).

Figure 2 displays the actual GDP and its stochastic trend generated by the model as well as the associated output gap. The latter is graphed together with the output gap derived from a linear-quadratic trend estimate of potential output. It is clear that the stochastic output gap estimates are smaller on the average than estimates of the linear-quadratic output gap. The reason is that shocks to potential output partly account for the fluctuations in GDP. It can also be observed that for the Philippines and Thailand, the stochastic output gap diagrams show the Asian crisis only as a slowdown and not as a recession. Here it should be noted that a large part of GDP movements during this period is due to some combination of shocks to potential output and radical deviations from trend growth. Hence, a recession need not necessarily be reflected as a negative output gap.

Table 2 presents GMM estimates of simple backward-looking Phillips curves (equation (4)) for the four countries, using the output gap estimates shown in Figure 2.²

$$\Delta p_t = \gamma_1 \Delta p_{t-1} + \gamma_2 z_t \quad (4)$$

The upper half of the Table shows that the estimate of γ_2 for Thailand is not significant and is insignificant and incorrectly signed for Malaysia when the linear-quadratic output gap is used. The bottom half of the Table indicates that the γ_2 estimates using the stochastic output gap are significant for all countries except for Indonesia; also they are in general larger compared to the other set of estimates. For γ_2 coefficients that are significant, the implied sacrifice ratio is less than one for Malaysia and the Philippines and is greater than two for Thailand and Indonesia.

4 Concluding remarks

Measurement of the output gaps in developing economies has not been attempted before and some findings above which are new need further scrutiny. The results shown in the right column of Figure 2 need to be interpreted with caution as it appears that for some countries, the output gap is not measuring business cycles. From the point of view of dynamic stochastic general equilibrium modeling, Neiss and Nelson (2002) point out that this would be the case when the output gap is thought to exist only because of the presence of nominal rigidities in the economy. Thus, the output gap can be positive, zero or negative during a recession (negative growth) depending on whether the source of this downturn is real or nominal. The policy responses to the Asian crisis differed from country to country. It is possible then that the difference in the result between Thailand and the Philippines on the one hand and Malaysia and Indonesia on the other

² Lagged inflation proxies for $E_{t-1}\Delta p_t$, the expectation of current inflation using previous period information. Four lags each of inflation and output gap are used as instruments. Overidentifying restrictions for all GMM estimates above cannot be rejected.

is due to differences in policy responses to the crisis and the extent of nominal rigidities in these economies. This is not explored in this study but is an area for further research.

References

- Bautista, C. (2002), "Interest rate-exchange rate dynamics in the Philippines: A DCC analysis," *Applied Economics Letters*, forthcoming.
- Clarida R., Gali, J. and M. Gertler (2000), "Monetary policy rules and macroeconomic stability: Evidence and some theory," *Quarterly Journal of Economics*, 115, issue 1, 147-180.
- Clark, P. (1989), "Trend reversion in real output and unemployment," *Journal of Econometrics*, 40, 15-32.
- Hamilton, J. (1989), "A new approach to the economic analysis of nonstationary time series and the business cycle," *Econometrica*, 57, No. 2, 357 - 384.
- Kim, C.J. (1994), "Dynamic linear models with Markov-switching," *Journal of Econometrics*, 60, 1-22.
- Kim, C.J. and C. Nelson (1999), *State-Space Models with Regime Switching*, The MIT Press, Cambridge, Massachusetts, USA.
- Kuttner, K. (1994), "Estimating potential output as a latent variable," *Journal of Business and Economic Statistics*, 12 No. 3, 361-368.
- Lam, P. (1990), "The Hamilton model with a general autoregressive component," *Journal of Monetary Economics*, 26, 409-432.
- Neiss, K., and E. Nelson, (2002) "Inflation dynamics, marginal cost, and the output gap: Evidence from three countries," paper presented in the "Macroeconomic Models for Monetary Policy," Federal Reserve Bank of San Francisco/SIEPR conference, March 2002.
- Roberts, J. (1995), "New Keynesian Economics and the Phillips Curve," *Journal of Money, Credit and Banking*, 27 No. 4 Part I, 975-984.
- Watson, M. (1986), "Univariate detrending methods with stochastic trends," *Journal of Monetary Economics*, 18, 49 - 75.

Table 1
Parameter Estimates of the Generalized Hamilton Model
(standard errors are in parenthesis)

	p_{00}	p_{11}	ϕ_1	ϕ_2	σ	μ_0	μ_1	Log-likelihood
Indonesia 93:01 – 02:2	0.972 *(0.028)	0.739 *(0.208)	0.932 *(0.146)	-0.217 *(0.068)	1.578 *(0.178)	-5.239 *(0.657)	6.771 *(0.772)	-77.901
Malaysia 91:01 – 02:2	0.948 *(0.037)	0.728 *(0.158)	0.336 *(0.199)	-0.004 (0.093)	1.335 *(0.161)	-2.075 *(0.230)	4.310 *(0.256)	-89.729
Philippines 90:01 – 02:2	0.917 *(0.049)	0.593 *(0.197)	0.682 *(0.224)	0.175 (0.226)	0.686 *(0.077)	-0.729 *(0.352)	1.793 *(0.335)	-64.366
Thailand 93:01 – 02:2	0.970 *(0.030)	0.670 *(0.262)	0.926 *(0.192)	0.032 (0.192)	1.677 *(0.205)	-4.265 *(1.390)	5.568 *(1.404)	-77.564

* significant at 5 percent

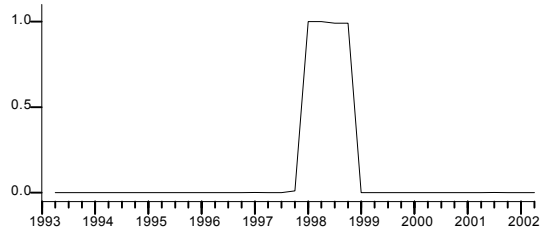
Table 2
GMM Estimates of Phillips Curve Parameters
Instruments used: four lags each of inflation and output gap
(standard errors are in parenthesis)

Output gap derived from a linear-quadratic trend				
	Indonesia 94:2-02:2	Malaysia 92:2-02:2	Philippines 91:2-02:2	Thailand 94:2-02:2
γ_1	0.505 *(0.073)	0.974 *(0.072)	0.999 *(0.045)	0.259 *(0.102)
γ_2	0.179 *(0.051)	-0.038 (0.026)	0.092 **(0.051)	0.006 (0.020)
Output gap derived from a stochastic trend				
	Indonesia 94:2-02:2	Malaysia 92:2-02:2	Philippines 91:2-02:2	Thailand 94:2-02:2
γ_1	0.946 *(0.083)	0.613 *(0.134)	0.961 *(0.043)	0.371 *(0.055)
γ_2	0.108 (0.133)	0.699 *(0.222)	0.263 **(0.148)	0.265 *(0.036)

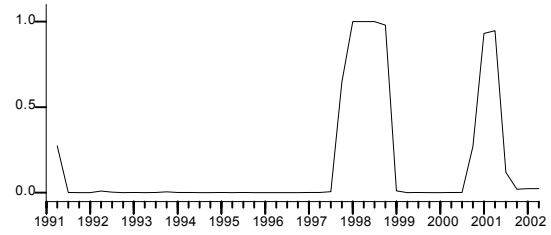
* significant at 5 percent

** significant at 10 percent

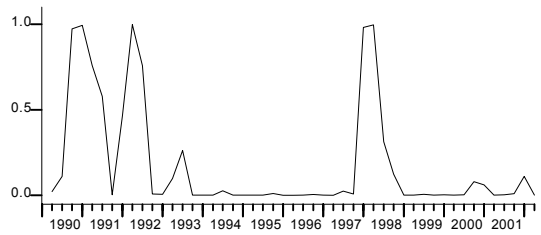
Figure 1 - Smoothed probability of a low growth state



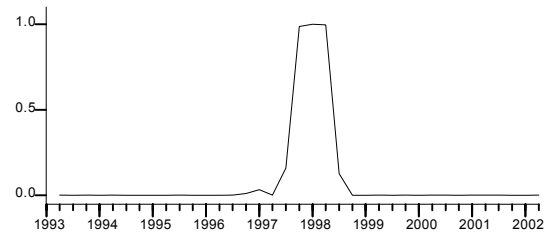
Indonesia



Malaysia



Philippines

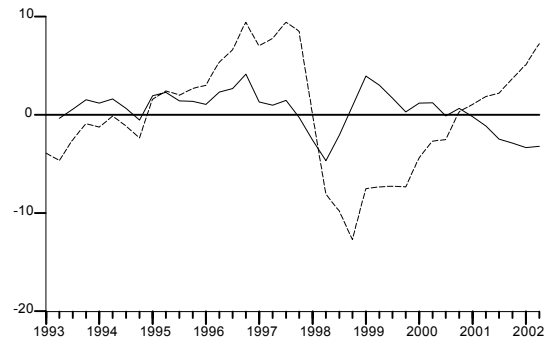
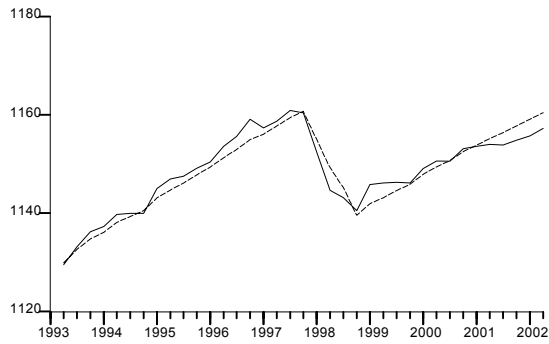


Thailand

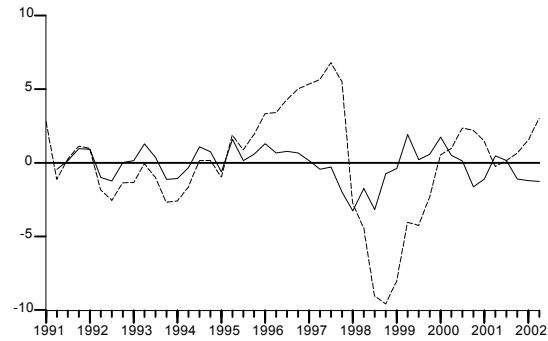
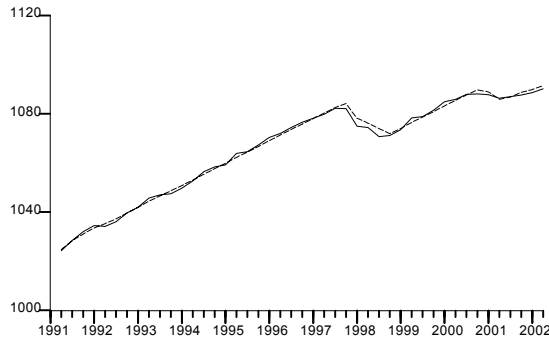
Figure 2 - Actual GDP, trend GDP and the output gap

GDP: — actual
 - - - stochastic trend

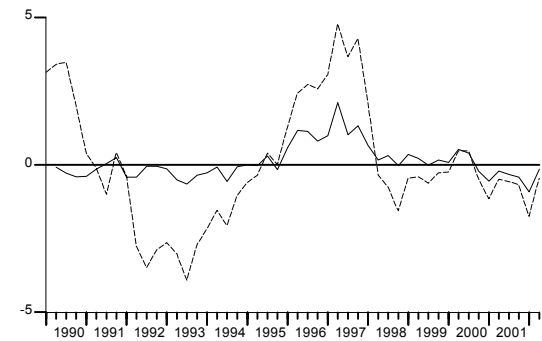
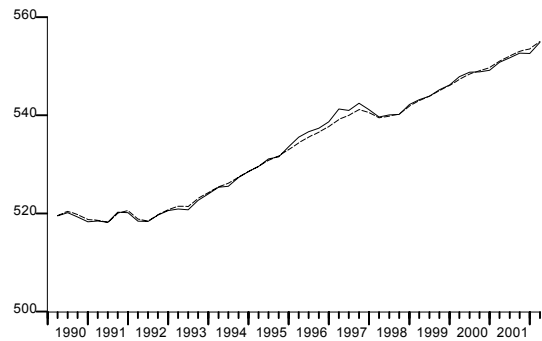
Output gap: — using stochastic trend
 - - - using linear-quadratic trend



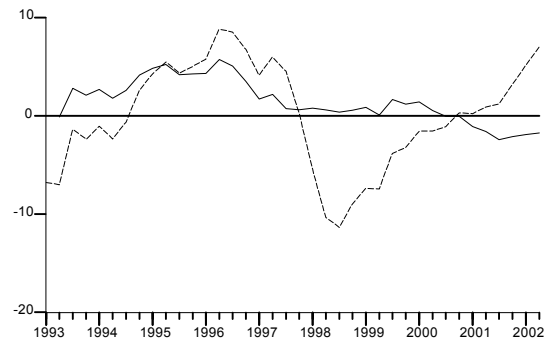
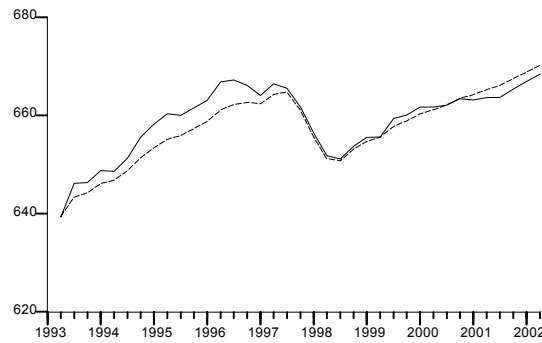
Indonesia



Malaysia



Philippines



Thailand