Unobserved Component Models of the Phillips Relation in the ASEAN Economy

Warapong Wongwachara
Faculty of Economics and Politics, University of Cambridge, UK

Anusorn Minphimai*
Fiscal Policy Research Institute, Thailand

The subject of this paper is the estimation of the Phillips relation – the inflation-output gap tradeoff – for ASEAN countries. Unobserved component (UC) models are employed in order to extract the output gap from GDP data. We also obtain stylised facts on macroeconomic cycles namely, (i) that the average cyclical period for output is approximately four years, and (ii) that the output movement leads that of investment. The inflation equation is then estimated as part of a bivariate model that includes an equation for GDP; the lagged output gaps enter the inflation equation as additional explanatory variables. The evidence for the significant relationship between the output gap and inflation in ASEAN appears to be very weak.

Keywords: unobserved component model, Phillips relation, output gap, ASEAN

JEL classification: C22, C32, E31, E32

1 Introduction

In his PhD Thesis, A. W. Phillips postulates a relationship between a price-level change and deviation of actual production from the equilibrium level, the
relationship known as the first ‘Phillips Curve’ (Wulwick, 1989).¹ No consensus about the soundness of this “theory” has been reached, however. Milton Friedman (1968:8), for example, rejects it on grounds that the relationship entails ‘a world in which everyone anticipated that nominal prices would be stable and in which that anticipation remained unshaken and immutable whatever happened to actual prices and wages’.

Although it is now generally accepted that there is no output-inflation tradeoff in the long run, the idea of the Phillips relation prevails. For the US economy, for instance, Romer (2006) documents evidence of a stable Phillips relationship during the 1960s; the relationship albeit seems to break down subsequently. In the literature, the modern Phillips relation is usually of the form:

\[
\pi_t - \pi^*_t = \lambda (\ln Y_t - \ln \bar{Y}_t) + \epsilon_t, \quad \lambda > 0,
\]

where \(\pi_t\) is the inflation rate, \(\pi^*_t\) the expected or underlying inflation, \(Y_t\) the output, and \(\bar{Y}_t\) the natural-rate or potential output, and \(\epsilon_t\) reflects cost-push inflation. In Eq. (1), the departure of the present inflation from the expected inflation is proportional to output gap—the difference between the present output and the natural rate output.

In order to estimate \(\lambda\) in the Phillips relation above, it is necessary that a researcher obtain ‘detrended’ series for both inflation and output. The conventional wisdom is to mechanically apply moving average filters such as the well-known Hodrick-Prescott filter to the GDP data; however, such practice could end up generating cycles that are spurious (Harvey and Jaeger, 1993). An alternative modelling approach exists for extracting the output gap, namely Unobserved Component (UC) models. As shall be illustrated, UC models are also more attractive than the prominent regression-type approach (e.g. in Lucas (1972), and Ball et al. (1991)) as they decompose observed series into (unobserved) components which have a natural interpretation.

We therefore employ UC models in the investigation of the tradeoff between inflation and the output gap in the ASEAN economy.² We examine four ASEAN

¹The conventional Phillips curve is plotted for unemployment rate against wage inflation. To distinguish the relationship in the context of this paper, and the usual practice, we use the term ‘Phillips relation’ instead.

²ASEAN, the Association of Southeast Asian Nations, comprises ten member countries: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. In 2007, the GDP at current price of the region amounts to US$1,281,853.9 million, a growth
countries with the intention to come up with critical information for the policy
design of this particular region. The paper adds to the literature on the Phillips
relation in ASEAN which is active and shows inconclusive results. Dua (2006)
[using OLS] and Bautista (2003) [GMM], for instance, reject the existence of the
[GMM], and Bhanthumnavin (2002) [OLS] are in favour of the significant Phillips
relation. None of the studies has employed the UC modelling approach.

The rest of the paper is organised as follows. The next section outlines standard
UC models. Section 3 describes the data used, as well as the estimation and testing
procedure of various UC models. The equations for the Phillips relation are
presented and estimated in Section 4. Implications for the ASEAN case are then
drawn, and conclusions reached. The last section also addresses limitations, and
suggests plausible extensions of the study.

2 Unobserved Component Models

Harvey (1993: 120) defines an unobserved component model, also sometimes
referred to as a structural time-series model, as ‘one which is set up in terms of
components which have a direct interpretation’. Analogously to the classical
decomposition, in UC models, an observed variable $y_t$ can be “decomposed” as the
sum of a trend, cycles, terms for seasonality, and irregular movements.

An UC model for quarterly GDP can be formulated, following Harvey (1993),
as follows.

$$y_t = \mu_t + \psi + \epsilon_t + \varepsilon_t \sim \text{nid}(0, \sigma^2_t), \quad t = 1, \ldots, T,$$

(2)

where $y_t$ is the observation at time $t$; the terms on the right hand side designate
trend, seasonal, cyclical, and irregular components, respectively. The underlying
trend can be modelled as stochastic in both level, $\mu_t$, and slope, $\beta_t$, as shown in Eq.
(3).

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t, \quad \eta_t \sim \text{nid}(0, \sigma^2_{\mu}),$$

(3)

of 6.5% from previous year, while annual inflation rates (year-on-year growth of CPI) range from 0.0% in
Myanmar to 6.6% in Indonesia (ASEAN, 2008).
\[ \beta_t = \beta_{t-1} + \xi_t, \quad \xi_t \sim \text{nid}(0, \sigma^2_{\xi}). \]

Furthermore, the seasonal components should be included because the IMF data have not been seasonally adjusted (to be explained in Subsection 3.2). The seasonal effects sum up to zero over a year \((s = 4 \text{ herein})\). This sum is then allowed to follow a random term:

\[ \sum_{j=0}^{s-1} \gamma_{t-j} = \omega_t, \quad \omega_t \sim \text{nid}(0, \sigma^2_{\omega}). \quad (4) \]

Finally, the cyclical components are modelled in terms of stochastic trigonometric functions:

\[
\begin{bmatrix}
\psi_t \\
\psi_t^*
\end{bmatrix} = \rho \begin{bmatrix}
\cos \lambda_t \\
-\sin \lambda_t
\end{bmatrix} \begin{bmatrix}
\psi_{t-1} \\
\psi_{t-1}^*
\end{bmatrix} + \begin{bmatrix}
\kappa_t \\
\kappa_t^*
\end{bmatrix}, \quad \kappa_t, \kappa_t^* \sim \text{nid}(0, \sigma^2_{\kappa}). \quad (5)
\]

where \(0 \leq \rho \leq 1\) and \(0 \leq \lambda_t \leq \pi\) are respectively the damping factor on the amplitude of the “waves”, and the frequency of the cycles. Another characteristic of cycles which is directly related to the frequency is the period – the time required for each wave to cycle – which is equal to \(\frac{2\pi}{\lambda_t}\).

In addition to the unobserved components, it is not unusual to include other exogenous variables on the right hand side of Eq. (2). This property of UC models allows us to incorporate other useful information of ASEAN economy into the model. An intervention dummy, for example, can be inserted to capture structural breaks in the data. In our study, because of the 1997 Asian economic crisis, a level intervention – which is a dummy variable that takes value 1 at and after the time of change – may be included to help explain GDP. As the crisis broke out during the third quarter of 1997, intervention is made from 1998 Q1 onwards, allowing a quarter lag for the effect to realise. This is congruous to the actual data.

In theory, one might prefer UC models to ARMA-type models in which the dynamics of model depends only on lagged dependent variable. This is because the ARMA-type models suffer from implicitly imposing the underlying level on the dynamics of model. UC models, on the other hand, infer the dynamics from actual observations, permitting as well local trend and local seasonality – which translate to
unit-root and seasonal-unit-root behaviours in ARMA terminology. Moreover, in economics, an unobserved components representation is often a natural way in which to proceed because the components can be identified with features, which have interpretation, unlike the ARMA-type model that rarely contains economic meanings. Finally, although it is true that every UC formulation has its ARMA equivalent (or ARMA representation) (Harvey, 1993: 30), difficulties to formulate cyclical components into ARMA model raises practical problems, adding another disadvantage of ARMA model.

UC models can be estimated by formulating a state-space form, and calculating the Maximum Likelihood estimators via the Kalman filter and the prediction error decomposition (see Harvey (1989) for details). Fortunately, there are a number of computer packages that can handle UC models conveniently; among others is STAMP 6.0 by Koopman et al. (2000), which is employed in the present research.

3 Output Gap and Macroeconomic Stylised Facts

This section describes how the output gap can be extracted from the GDP data. We measure the output gap by the cycles, $\psi_t$, in the UC models, as suggested by Harvey et al. (2007).

3.1 UC model Specification, Estimation, and Selection

Two classes of UC models are considered. The first one is univariate; Harvey (1989) points out that such models serve well as a base against which more complicated models can be evaluated. The other class of models is bivariate – between GDP and

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3Without loss of generality, consider a simple UC model with seasonality: $y_t = y_s + \epsilon_t$, where the seasonality $y_s$ is described by Eq. (4).

Define $\Delta_s = 1 - L^S$, and $S(L) = 1 + L + L^2 + \ldots + L^S$. We can immediately see that $\Delta_s = S(L)$. Hence, we can re-write Eq. (7) as

$$\Delta_s y_t = \Delta_s y_t + \Delta_s \epsilon_t = \Delta_y + \Delta_s \epsilon_t = \Delta_y + \Delta_s \epsilon_t = M_s(s).$$

Therefore, the UC model already imposes the integrated (unit-root) seasonality behaviour of $y_s$, and hence such effects should be interpreted as ‘local’ seasonality.
Investment – in which both series are endogenous. The rationale behind the bivariate formulation is that investment data exhibit more pronounced cyclical movements than GDP, and hence they should help in the estimation of the GDP cycles (Harvey and Trimbur, 2003).

Specification in each class of models is based on the principle of parsimony (Harvey, 1993: 73). The approach is to initially allow the variances of the components to vary freely. If any variance estimates turn out to be extremely low (close to zero), then another model shall be estimated with that particular variance restricted to zero, in effect, making the corresponding component deterministic.

Model selection criteria are based on Koopman et al. (2000). First and foremost, it is suggested that the convergence of the numerical Maximum Likelihood estimation be examined. Koopman et al. suggest that ‘strong convergence’ is a necessary condition for the model to be suitably specified, and that failure to satisfy such a condition might be a symptom of misspecification. Additional test statistics are inspected, namely, the standard deviation of the equation (\( \hat{\sigma} \)), the “seasonally adjusted” goodness of fit (\( R^2_t \)), the Box-Ljung \( Q \) statistics, the heteroscedasticity \( H \) statistics, and the normality test \( N \) statistics.

The first two statistics measure the fit of a given model; \( R^2_t \) in particular compares the fit of a given model with a random walk with fixed seasonal dummies. The other test statistics constitute diagnostic checking on the disturbances. \( Q \) tests serial correlation in the disturbance terms up to lag \( p \) under the null hypothesis of uncorrelated disturbances. \( H \), computed from the ratio of the squares of the last \( h \) residuals to those of the first \( h \) residuals, detects heteroscedasticity, under the null of homoscedasticity. Finally, \( N \) is a usual Jarque-Bera test under the null of Normality. Ideally, we expect the residuals to be serially uncorrelated, homoscedastic, and normally distributed (Harvey and Koopman, 1992).

### 3.2 Data

The macroeconomic time series are obtained from the IMF database. Only four countries in ASEAN, nevertheless, have complete data on which studies can be conducted. These countries are Indonesia, Malaysia, the Philippines, and Thailand. Others are dropped on grounds of data insufficiency. (For instance, Cambodia,
Myanmar, and Vietnam do not have data for the national accounts; the IMF database does not provide the complete series for investment expenditure for Brunei or Singapore either.) Three quarterly macroeconomic time series are considered for each country: real GDP (in log), inflation (percent per annum), and real investment (in log). Details of the source and further descriptions can be found in the appendix.

3.3 Estimation Results and the Stylised Facts

The estimation results for various specifications are shown in Table 1. The shaded rows indicate the “best” specification for each country, of which estimated cyclical components are saved and will be used in the estimation of the Phillips relation. Consistent with the claim made by Harvey and Trimbur (2003) in modelling the US economy, the bivariate models for ASEAN data do provide better fit than their univariate counterparts. However, the improvement in goodness of fit in our cases seems marginal; the standard deviations hardly reduce, while $R^2$’s increase only slightly. All the chosen (bivariate) models achieve ‘very strong convergence’ in the estimation. Moreover, their disturbances are found to be in good condition; though some of the models still exhibit non-normality.

The extracted cyclical components (of both GDP and Investment) offer some macroeconomic stylised facts for the ASEAN economy. The estimated cyclical periods range from about two and a half years for Indonesia to well below five years for the Philippines. The average cyclical period, nevertheless, is noticeably smaller than that of the seasonally adjusted US GDP which is reportedly equal to 5 years (Harvey and Trimbur, 2003). Furthermore, not only are investment cycles more pronounced than those of GDP, they do lag those of GDP, though only slightly. See Figure 1. Such an observation is consistent with an argument of standard multiplier-accelerator models – which hypothesise a positive effect on private fixed investment of the growth of the economy.
4 The Output-Inflation Tradeoff

This section concerns the estimation of the Phillips relation, and is central to the present research. The output gaps, which are earlier extracted, act as additional explanatory variables in the inflation equation.

<table>
<thead>
<tr>
<th>Country</th>
<th>Model</th>
<th>Restrictions</th>
<th>Conv</th>
<th>$\sigma_\epsilon$</th>
<th>$\sigma_\sigma$</th>
<th>$\sigma_\omega$</th>
<th>$\rho$</th>
<th>$2\pi / \hat{\lambda}$</th>
<th>$\hat{\sigma}$</th>
<th>$R^2$</th>
<th>$Q$</th>
<th>$H$</th>
<th>$N$</th>
</tr>
</thead>
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<td>GDP</td>
<td>None</td>
<td>V/S</td>
<td>0.00</td>
<td>0.53</td>
<td>2.47</td>
<td>3.52</td>
<td>2.05</td>
<td>0.93</td>
<td>2.60</td>
<td>0.01</td>
<td>0.45</td>
<td>0.48</td>
</tr>
<tr>
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<td></td>
<td>$\hat{\sigma}_\epsilon = \hat{0}$</td>
<td>V/S</td>
<td>-0.53</td>
<td>2.47</td>
<td>3.52</td>
<td>2.05</td>
<td>0.93</td>
<td>2.60</td>
<td>0.01</td>
<td>0.45</td>
<td>0.48</td>
<td>0.99</td>
</tr>
<tr>
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<td>V/S</td>
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<td>0.62</td>
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<td>3.40</td>
<td>1.94</td>
<td>0.94</td>
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<td>0.58</td>
<td>0.15</td>
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<td>V/S</td>
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<td>3.39</td>
<td>1.99</td>
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<td>$\hat{\sigma}_\epsilon = \hat{0}$</td>
<td>V/S</td>
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<td>2.53</td>
<td>3.39</td>
<td>1.99</td>
<td>0.94</td>
<td>0.99</td>
<td>0.01</td>
<td>0.58</td>
<td>0.14</td>
<td>0.99</td>
</tr>
<tr>
<td>Philippines</td>
<td>GDP</td>
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<td>S</td>
<td>2.04</td>
<td>0.79</td>
<td>0.89</td>
<td>4.45</td>
<td>0.00</td>
<td>0.01</td>
<td>0.45</td>
<td>0.01</td>
<td>0.58</td>
<td>0.15</td>
</tr>
<tr>
<td>GDP</td>
<td></td>
<td>$\hat{\sigma}_\epsilon = \hat{0}$</td>
<td>V/S</td>
<td>-0.79</td>
<td>0.49</td>
<td>4.22</td>
<td>-0.85</td>
<td>3.42</td>
<td>0.01</td>
<td>0.34</td>
<td>0.21</td>
<td>0.99</td>
<td>0.01</td>
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<tr>
<td>GDP</td>
<td>None</td>
<td>V/S</td>
<td>0.00</td>
<td>0.79</td>
<td>0.89</td>
<td>4.45</td>
<td>0.00</td>
<td>0.87</td>
<td>3.97</td>
<td>0.01</td>
<td>0.35</td>
<td>0.09</td>
<td>0.99</td>
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<td>1.21</td>
<td>5.40</td>
<td>1.01</td>
<td>4.38</td>
<td>0.01</td>
<td>0.18</td>
<td>0.18</td>
<td>0.99</td>
</tr>
<tr>
<td>GDP</td>
<td></td>
<td>$\hat{\sigma}_\epsilon = \hat{0}$</td>
<td>V/S</td>
<td>-1.54</td>
<td>1.21</td>
<td>5.40</td>
<td>1.01</td>
<td>4.38</td>
<td>0.01</td>
<td>0.18</td>
<td>0.18</td>
<td>0.99</td>
<td>0.44</td>
</tr>
</tbody>
</table>

Notes: i) the estimated standard deviations are multiplied by 1,000; ii) ‘Conv’ shows the convergence criterion – V/S and S refer to Very Strong and Strong respectively; iii) $2\pi / \hat{\lambda}$ is reported in years; iv) the number of lags in $Q$ statistic is chosen by STAMP such that the degree of freedom is always 6; v) $h$’s are selected by STAMP according to the number of observations, and take the values of 13, 18, 16, 18 for Indonesia, Malaysia, the Philippines, and Thailand, respectively; vi) all the figures in the $Q$, $H$ and $N$ columns are p-values; and vii) for the bivariate models, only the results for the GDP equation are reported.
4.1 The Model

The model for the present study is adapted from Harvey et al. (2007). Two modifications have been made. Firstly, the seasonal components are added, as our data have not been seasonally adjusted. Secondly, pulse dummies are included – these are dummy variables which assume 1 in a certain quarter, and 0 otherwise – in order to absorb the ‘outliers’ in inflation during the aftermath of the crisis, the quarters of year 1998 (see Figure 2 in the appendix). We apply a similar specification search as in Section 3 to include only significant dummies. The bivariate model for the output-inflation tradeoff is as follows.

$$\begin{bmatrix} \pi_t \\ y_t \end{bmatrix} = \begin{bmatrix} \mu^π_t \\ \mu^y_t \end{bmatrix} + \begin{bmatrix} \psi^π \\ \psi^y \end{bmatrix} + \begin{bmatrix} c_1 \psi^π_1 + c_2 \psi^π_2 + d \cdot \delta^π \\ 0 \end{bmatrix} + \begin{bmatrix} \epsilon^π_t \\ \epsilon^y_t \end{bmatrix},$$

(6)

where $y_t$ is real GDP (in log), $\pi_t$ the CPI rate of inflation, $\delta^π=(\delta_{98Q1}, \delta_{98Q2}, \delta_{98Q3}, \delta_{98Q4})$ a vector of the pulse dummies for crisis period (1998Q1 to 1998Q4) with their corresponding coefficients $d=(d_1, d_2, d_3, d_4)$, and
(.) the dot product; other notations, as well as the distributional assumptions, are the same as those in Eq. (2). Under this formulation, $\mu^*$ can be referred to as the underlying rate or ‘core’ inflation, or sometimes, as the expected inflation as it is filtered using information up to time $t$.

The dynamics of inflation is explained by the unobserved components, instead of the lagged values of $\pi$, as in conventional regression-type models. A disadvantage of the latter formulation is that a certain dynamic structure is readily imposed on $\mu^*$ (Harvey, 2008). The above UC model, nevertheless, shares some aspect with regression-type models. The lagged values of $\psi^*$, extracted from the prior UC models, are now exogenous, and are expected to help explain the movement of $\pi$, in addition to those explained by the unobserved components.

In order to produce the estimates for model (6), the same procedure described in Section 3 is followed. Moreover, we employ the general-to-specific approach (Hendry, 1995) in the inclusion decision of the pulse dummies. That is to say, we first include the pulse dummies for all four quarters of 1998, and then conduct a specification search by “testing down” i.e. dropping the insignificant dummies.

### 4.2 Results and Discussions

The estimated coefficients for the explanatory variables in the UC models can be interpreted as the usual regression coefficients, and their distributions will be asymptotically normal (Koopman et al., 2000). The final results are reported in Table 2. The model fits the data fairly well, especially for Indonesia. Most of the times, the disturbances achieve the ideal conditions. The included pulse dummies are found to be highly significant in explaining the movements in $\pi$.

Nevertheless, hardly any coefficients for the lagged output gaps are significant. The only significant coefficient, Indonesia’s $c_i$, is negative, and hence is counter-theoretical. Such results are, to certain extent, in line with the previous studies, including Dua (2006), and Bautista (2003). It might be therefore sound to conclude that the Phillips relation fails to hold in the ASEAN economies during the past
decade. The effect of change in unemployment, via output, on inflation – the conventional Phillips curve – should hence be trivial.

Table 2: Coefficient estimates for the output-inflation model

<table>
<thead>
<tr>
<th>Country</th>
<th>T</th>
<th>Pulse</th>
<th>$c_1$</th>
<th>$c_2$</th>
<th>$d_1$</th>
<th>$d_2$</th>
<th>$d_3$</th>
<th>$d_4$</th>
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<th>$Q$</th>
<th>$H$</th>
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<td>43</td>
<td>98Q4</td>
<td>-1064.9</td>
<td>285.59</td>
<td>-</td>
<td>-</td>
<td>8.52</td>
<td>-4.07</td>
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<td>0.41</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>(225.23)</td>
<td>(223.70)</td>
<td>(3.28)</td>
<td>(0.00)</td>
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<td>(0.01)</td>
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<tr>
<td>Malaysia</td>
<td>51</td>
<td>98Q1</td>
<td>-20.29</td>
<td>-4.53</td>
<td>1.48</td>
<td>2.93</td>
<td>2.42</td>
<td>1.63</td>
<td>0.48</td>
<td>0.32</td>
<td>0.42</td>
<td>0.53</td>
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<tr>
<td></td>
<td>98Q2</td>
<td>(15.16)</td>
<td>(15.39)</td>
<td>(0.50)</td>
<td>(0.62)</td>
<td>(0.63)</td>
<td>(0.52)</td>
<td></td>
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<tr>
<td></td>
<td>98Q3</td>
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<td>53</td>
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<td>31.15</td>
<td>499.43</td>
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<td>(397.11)</td>
<td>(397.31)</td>
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<td>[0.82]</td>
<td>[0.58]</td>
<td>[0.01]</td>
<td>[0.05]</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Notes: i) T is the number of observations used in the estimation; ii) ‘Pulse’ shows the periods at which dummy variables are present (see the text for descriptions); iii) the coefficients are reported together with RMSEs in (.) and the p-values in [.]; iv) the number of lags in $Q$ statistic is chosen by STAMP such that the degree of freedom is always 6; v) $h$’s are selected by STAMP according to the number of observations, and take the values of 12, 18, 17, 19 for Indonesia, Malaysia, the Philippines, and Thailand, respectively; vi) all the figures in the $Q$, $H$, and $N$ columns are p-values; and vii) the results for the GDP equation are omitted.

The fact that the Phillips relation does not seem to hold in ASEAN implies that expansionary monetary or fiscal policies will not significantly drive up inflation. On the other hand, if inflation is above the target, in order to bring inflation down, the economy might have to go through extensive contraction. These two cases, as Bean (2006) calls them, are the good and the bad news of the flattening Phillips relation for policy makers.

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4Gali and Gertler (1999), however, argue that it is not unusual to detect the statistically insignificant effect when the quarterly data are used in UC models. We thus have to reserve some scepticism on the results.
5 Conclusions

We have presented the unobserved components statistical methodology to the estimation of the Phillips relation – which theorises inflation as positively determined by output gap – in ASEAN economies. The output gaps are extracted from the equation for GDP as part of the GDP-investment bivariate model, and they are later used in the estimation of the Phillips relation.

As a by-product of the output gap extraction, two main macroeconomic stylised facts are derived: (i) on average it takes around four years for ASEAN’s GDP to complete its cycle; and (ii) an uprising GDP cycle signals investment growth. The main results on the output-inflation model indicate the absence of the Phillips relation in the four ASEAN countries. From a macroeconomic perspective, the obvious statistical evidence against the Phillips relation is plausibly a consequence of the rather stationary inflation within the region.

Although UC models are alternative – if not superior – to regression-type models in the estimation of the Phillips relation, they are not without flaws. Despite the fact that all the UC models perform fairly well according to the model selection criteria, all of the estimates of the damping factor, $\hat{\rho}$, are close or equal to unit, resulting in a near-deterministic or deterministic cycles. This is a symptom of model inappropriateness (Harvey, 1985). This could have resulted from our UC models being too simple. Harvey prescribes fitting a cyclical-trend model, in place of the usual trend-plus-cycle models. From a macroeconomic viewpoint, future research should incorporate the role of the labour market institutions which are expected to be another important determinant of the Phillips relation.

Appendix

The quarterly data used in throughout the research are obtained from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). They are recorded in national currency. The GDP are real GDP, with different base years across countries. IFS provides the instant inflation (INF) series, reportedly computed from the quarterly growth in CPI. Investment series are calculated from
real Gross Fixed Capital Formation (GFCF), using GDP deflator as a divisor. Detailed descriptions are present below. Time-series plots of the data are also shown in Figure 2.

<table>
<thead>
<tr>
<th>Country</th>
<th>Real GDP</th>
<th>INF</th>
<th>I</th>
<th>GDP Deflator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>1997Q1-2008Q1</td>
<td>2000 prices (billions)</td>
<td>CPI % change</td>
<td>GFCF (billions)</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1993Q1-2008Q1</td>
<td>2000 prices (billions)</td>
<td>CPI % change</td>
<td>GFCF (millions)</td>
</tr>
<tr>
<td>Philippines</td>
<td>1993Q1-2008Q1</td>
<td>1985 prices (billions)</td>
<td>CPI % change</td>
<td>GFCF (billions)</td>
</tr>
<tr>
<td>Thailand</td>
<td>1993Q1-2008Q1</td>
<td>1988 prices (billions)</td>
<td>CPI % change</td>
<td>GFCF (billions)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Country</th>
<th>Series</th>
<th>T</th>
<th>Mean</th>
<th>S.D.</th>
<th>Min</th>
<th>Max</th>
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</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>GDP</td>
<td>45</td>
<td>396,864</td>
<td>52,989.93</td>
<td>316,025</td>
<td>505,958</td>
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<tr>
<td></td>
<td>INF</td>
<td>45</td>
<td>14.22</td>
<td>17.49</td>
<td>-0.57</td>
<td>78.39</td>
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<tr>
<td></td>
<td>I</td>
<td>45</td>
<td>894.71</td>
<td>205.52</td>
<td>647.64</td>
<td>1,309.39</td>
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<tr>
<td>Malaysia</td>
<td>GDP</td>
<td>61</td>
<td>90,652.4</td>
<td>20,065.35</td>
<td>54,235.37</td>
<td>131,162</td>
</tr>
<tr>
<td></td>
<td>INF</td>
<td>61</td>
<td>2.72</td>
<td>1.20</td>
<td>0.77</td>
<td>5.73</td>
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<tr>
<td></td>
<td>I</td>
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<td>249.69</td>
<td>50.83</td>
<td>170.85</td>
<td>392.78</td>
</tr>
<tr>
<td>Philippines</td>
<td>GDP</td>
<td>57</td>
<td>243.94</td>
<td>45.58</td>
<td>175.04</td>
<td>381.92</td>
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<tr>
<td></td>
<td>INF</td>
<td>60</td>
<td>6.17</td>
<td>2.86</td>
<td>-1.47</td>
<td>11.02</td>
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<tr>
<td></td>
<td>I</td>
<td>57</td>
<td>1.62</td>
<td>1.34</td>
<td>1.34</td>
<td>2.02</td>
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<tr>
<td>Thailand</td>
<td>GDP</td>
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<td>814.26</td>
<td>134.97</td>
<td>588.14</td>
<td>1127.73</td>
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<tr>
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<td>2.40</td>
<td>-0.93</td>
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<td>I</td>
<td>61</td>
<td>3.86</td>
<td>0.93</td>
<td>2.22</td>
<td>5.49</td>
</tr>
</tbody>
</table>
Figure 2: Macroeconomic data

Indonesia
GDP 2000: 5.5
2005: 5.6

Malaysia
GDP 2000: 2.9
2010: 3.1

Philippines
GDP 2000: 0.2
INF 2000: 0

Thailand
GDP 2000: 0.4
INF 2000: 0
References


