Flattening of the Phillips curve and the role of the oil price: An unobserved component model for the USA and Australia

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**Abstract**

We used the unobserved component model of Harvey (1989, 2011) to estimate the Phillips curve for the USA and Australia, augmenting it with the oil price. Our results show that while the coefficient of demand pressure and the intercept decreased, the coefficient of the oil price increased. Therefore, the oil price is likely to play a significant role in future inflation rates.

JEL classification: C2, C12, E3

Keywords: Unobserved component model, USA, Australia, Flattening Phillips curve, Oil price

1. Introduction

Recent studies have found that since the late 1990s the Phillips curve (PC) has become flatter in countries like the USA, Canada and Australia; see Beaudry and Doyle (2000), Roberts (2006), Williams (2006), Mishkin (2007) and Kuttner and Robinson (2010). While the reasons for this are not well established, it has both positive and negative policy effects. Higher output levels can be achieved without increasing inflation by large amounts, but it would be costly to reduce entrenched inflation rates.

Previous studies have concentrated on the changes in the coefficient of the output gap (GAP) and have neglected the changes in the intercept and coefficients of other variables. This paper includes the oil price as an additional explanatory variable and employs the structural time series models of Harvey (1989, 2011) to analyze the coefficients of the GAP, the oil price, and the level component.\(^1\) The results for the US and Australia show that while the coefficient of the GAP and the intercept decreased, the coefficient of the oil price increased. The downward shift of the intercept and the GAP coefficient is consistent with the observed period of “Great Moderation” since the early 1980s; see Cogley et al. (2010) and Fuhrer (2009). However, an increase in the oil price coefficient implies increased dependence on energy prices, and if this continues, it will be more difficult to control the inflation dynamics.

The rest of the paper is as follows. Section 2 presents specifications, Section 3 contains results, and Section 4 makes conclusions.

2. Model specification

Our specification of the PC is adapted from Harvey (2011),\(^2\) with the GAP (\(\gamma^{PP}\)) as the driving force and the oil price as an additional

\(0165-1765/\$–\) see front matter © 2012 Elsevier B.V. All rights reserved.
doi:10.1016/j.econlet.2012.05.022

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\(^1\) The level component is equated to the intercept in the classical regression model. While the intercept is fixed in the classical regression, it is allowed to change over time in the time series structural models; see Commandeur and Koopman (2007).

\(^2\) Notice that (1) differs from the specifications used for the new Keynesian and hybrid new Keynesian Phillips curves in that neither \(\pi_{t-1}\) nor its expected one period ahead rate (\(E_\pi_{t+1}\)) are present. However, Harvey (2011) shows that under some assumptions Eq. (1) is consistent with a backward-looking behavior and a forward-looking dynamic. As for the lagged term, it is sufficient to observe that
explanatory variable; see Fuhrer (1995) and Blanchard and Gali (2007).

\[ \pi_t = \mu_t + \gamma_t + \psi_t + \phi_1, t^{\text{gap}} + \phi_2, t^{\text{oil}} + \epsilon_t, \]

\[ \epsilon_t \sim N \left(0, \sigma^2_\epsilon\right), t = 1, \ldots, T. \] (1)

Observed series of inflation (\(\pi_t\)) is decomposed into trend (\(\mu_t\)), cycle (\(\gamma_t\)), explanatory variable; see Fuhrer (1995) and Blanchard and Gali (2007). cycle (\(\psi_t\)), and seasonality (\(\gamma_t\)) components. Oil is the cyclical component of the oil price. \(\phi^{\text{gap}}\) and oil are obtained through the univariate trend–cycle decomposition. The component \(\mu_t\) is specified as random walk plus noise model:

\[ \mu_t = \mu_{t-1} + \eta_t \quad \eta_t \sim N \left(0, \sigma^2_\eta\right). \] (2)

The seasonal component \(\gamma_t\) has the following trigonometric form:

\[ \gamma_t = \sum_{j=1}^{s/2} \gamma_{j,t} \] (3)

where \(s\) is the seasonal length (for quarterly data, \(s = 4\)) and each \(\gamma_{j,t}\) is generated by:

\[ \gamma_{j,t}^{\text{gap}} = \begin{bmatrix} \cos \lambda_j & \sin \lambda_j \\ -\sin \lambda_j & \cos \lambda_j \end{bmatrix} \gamma_{j,t-1}^{\text{gap}} + \begin{bmatrix} \omega_{j,t}^{\text{gap}} \csc T \\ \omega_{j,t}^{\text{gap}} \sin T \end{bmatrix}, \quad j = 1, \ldots, s/2, \]

\[ \gamma_{j,t}^{\text{oil}} = \begin{bmatrix} \cos \lambda_j & \sin \lambda_j \\ -\sin \lambda_j & \cos \lambda_j \end{bmatrix} \gamma_{j,t-1}^{\text{oil}} + \begin{bmatrix} \omega_{j,t}^{\text{oil}} \csc T \\ \omega_{j,t}^{\text{oil}} \sin T \end{bmatrix}, \quad j = 1, \ldots, s/2. \] (4)

In \((4), \lambda_j = 2\pi j/s\) is the seasonal frequency in radians, and \(\omega_{j,t}^{\text{gap}}\) and \(\omega_{j,t}^{\text{oil}}\) are NID seasonal disturbances with zero mean and common variance \(\sigma^2_\epsilon\).

The statistical specification of the cycle, \(\psi_t\), is given by the following:

\[ \psi_t = \rho \phi \begin{bmatrix} \cos \lambda_c & \sin \lambda_c \\ -\sin \lambda_c & \cos \lambda_c \end{bmatrix} \psi_{t-1} + \begin{bmatrix} \kappa_t \csc T \\ \kappa_t \sin T \end{bmatrix}, \quad t = 1, \ldots, T. \] (5)

where \(\rho \phi\) (in the range \(0 < \rho \phi \leq 1\)) is a damping factor; \(\lambda_c\) is the frequency, in radians, in the range \(0 \leq \lambda_c \leq \pi\); \(\kappa_t\), \(\kappa^*_t\) are NID disturbances with zero mean and common variance \(\sigma^2_\epsilon\).

The coefficients \(\phi_{1,t}\) and \(\phi_{2,t}\) are assumed to vary over time according to a smoothing spline process:

\[ (\phi_{1,t} - \phi_{1,t-1}) = (\phi_{1,t-1} - \phi_{1,t-2}) + u_{1,t} \quad u_{1,t} \sim N \left(0, \sigma^2_\epsilon\right). \] (6)

Estimation for the US and Australian PCs in \((1)-\(6)\) are in Table 1. For the Australian PC, the seasonal component \(\gamma_t\) is ignored because it was found to be statistically insignificant. Inclusion of \(\gamma_t\) did not change the results.

Fig. 1. Coefficients with 2SEs of the US Phillips curve. Panel 1: GAP (\(\phi_1\)); Panel 2: oil price (\(\phi_2\)); Panel 3: level component (\(\mu\)).

3 Inserting the cycle into the formula gives a smaller equation standard error. But more important, \(\mu\) is much more erratic.

4 We focused on the past 30 years because large outliers are detected by STAMP prior to 1978. In addition, diagnostic tests are more robust if we start from 1978.

5 The output gap is insignificantly different from zero in the 1990s onwards for the US and Australia. This is not new and is similar to the Kuttner and Robinson (2010) result.


7 The results are very similar if we use CPI as a measure of inflation.
increase in the coefficient of oil is similar to the US pattern. Therefore, the oil price in Australia is also likely to play a significant role in inflation in the future.

4. Conclusions

This paper followed the unobservable component approach of Harvey (1989, 2011) to estimate the Phillips curve for the US and Australia. Our specifications included oil prices as an additional explanatory variable. We found that in both countries, while the long-term coefficient of inflation (core inflation) and the coefficient of demand pressure have shown downward trends, the coefficient of the oil price has shown an upward trend. The positive effects on the inflation policy due to the declines in the level component and the output gap coefficient seem to be the result of a strong commitment by monetary authorities to lower inflation targets and possibly liberalization policies (i.e., capital account openness). The increase in the coefficient of the oil price could be due to a gradual increase in the relative price of energy and the relatively inelastic demand for energy. This implies that energy prices are likely to play a significant role in determining future rates of inflation. Therefore, strategies to reduce dependence on oil might be important for the future inflation policy.

Some issues that could be subject to the future investigation include: a comparison of the output gap with that of other measures, inclusion of import prices, exchange rate influences and extension to other countries.

Appendix. Data appendix

Table 1
Phillips curve estimation results of various models.

<table>
<thead>
<tr>
<th></th>
<th>$\phi_1$</th>
<th>$\phi_2$</th>
<th>PEV</th>
<th>$R^2$</th>
<th>$Q$</th>
<th>$N$</th>
<th>$H$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model A</td>
<td></td>
<td></td>
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<tr>
<td>USA</td>
<td>0.235</td>
<td>0.013</td>
<td>8.53E−05</td>
<td>0.320</td>
<td>0.128</td>
<td>0.018</td>
<td>0.941</td>
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<tr>
<td>Australia*</td>
<td>0.456</td>
<td>0.094</td>
<td>8.10E−04</td>
<td>0.535</td>
<td>0.241</td>
<td>0.221</td>
<td>0.738</td>
</tr>
<tr>
<td>$\pi_t = \mu + \psi_1 + \gamma + \phi_1 y_{\text{oil}} + \phi_2 \text{oil}_t + \epsilon_t$</td>
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Model B

|                       |          |          |       |       |       |     |       |
| USA                   | (See plots) | (See plots) | 8.44E−05 | 0.339 | 0.173 | 0.012 | 0.962 |
| Australia*            | (See plots) | (See plots) | 7.00E−04 | 0.606 | 0.140 | 0.122 | 0.917 |
| $\pi_t = \mu + \psi_1 + \gamma + \phi_1 y_{\text{oil}} + \phi_2 \text{oil}_t + \epsilon_t$ |

Notes: PEV = Prediction Error Variance; $R^2 =$ Coefficient of determination (*seasonally* adjusted goodness of fit for the US since we have a seasonal component); $N =$ Normality statistic (Bowman–Shenton statistic with the correction of Doornik–Hansen); $H =$ Heteroskedasticity test; $Q =$ Box–Ljung Q-statistic. For $Q$, $N$, and $H$ test we report $p$-value. The proper lag lengths in $Q$ and the degree of freedom are selected automatically by STAMP. $H$‘s in $H(h)$ test are selected by STAMP according to the number of observations.

* In Australia the seasonal component is not included.
' Significant at 5%.

References


Fig. 2. Coefficients with 2SEs of the Australian Phillips curve. Panel 1 GAP ($\phi_1$); Panel 2: oil price ($\phi_2$); Panel 3: level component ($\mu$).

Table 1 Phillips curve estimation results of various models.