Flattening of the Phillips Curve and the Role of Oil Price: An Unobserved Components Model for the USA and Australia

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6 March 2011

1977 words

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An Unobserved Components Model for the USA and Australia

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Abstract

We use the unobserved components model of Harvey (1989 and 2011) to estimate the Phillips curve (PC) for the USA and Australia, by augmenting it with oil prices. We found that the level coefficient of inflation and the coefficient of demand pressure have declined and contributed to the flattening of the Phillips curve. But the coefficient of oil prices has increased and has partly offset these effects. Therefore, oil prices are likely to play a significant role in future inflation rates.

Keywords: Unobserved components, Harvey, USA, Australia, Flattening of the Phillips curve and Oil prices

JEL: C2, C12, E3.

1. Introduction

Some 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). Although reasons for this are not well established, it has positive and negative policy effects. While higher output levels can be achieved without increasing inflation by larger amounts, it will be more costly to reduce entrenched inflation rates. This last effect will increase if the PC shifts up due to shifts in the intercept and/or in the coefficient of another explanatory variable e.g., oil/energy prices.

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

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

[1] The level component can be equated to 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. Model specification

Our specification of the US and Australia PCs is adapted from Harvey (2011)[2] with the GAP (y^{gap}) as the driving force and oil prices as an additional explanatory variable; see Fuhrer (1995) and Blanchard and Gali (2007).

$$\pi_t = \mu_t + \gamma_t + \psi_t + \phi_{1,t} y_t^{gap} + \phi_{2,t} oil_t + \varepsilon_t, \quad \varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right), \quad t = 1, \ldots, T \tag{1}$$

Observed series of inflation (π_t) is decomposed into trend (μ_t), cycle (ψ_t) , and seasonality (γ_t) components. oil is the cyclical component of oil prices. y^{gap} and oil are obtained through an univariate trend-cycle decomposition. The component μ_t is specified as random walk plus noise model:

$$\mu_t = \mu_{t-1} + \eta_t \quad \eta_t \sim N\left(0, \sigma_\eta^2\right) \tag{2}$$

The seasonal component γ_t has the following trigonometric form:

$$\gamma_t = \sum_{j=1}^{s/2} \gamma_{j,t} \tag{3}$$

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

$$\begin{bmatrix} \gamma_{j,t} \\ \gamma_{j,t}^* \end{bmatrix} = \begin{bmatrix} \cos\lambda_j & \sin\lambda_j \\ -\sin\lambda_j & \cos\lambda_j \end{bmatrix} \begin{bmatrix} \gamma_{j,t-1} \\ \gamma_{j,t-1}^* \end{bmatrix} + \begin{bmatrix} \omega_{j,t} \\ \omega_{j,t}^* \end{bmatrix}, \quad \begin{matrix} j = 1, \ldots, \ s/2 \\ t = 1, \ldots, T \end{matrix} \tag{4}$$

In (4) $\lambda_j = 2\pi j / s$ is the seasonal frequency in radians, and ω_t, ω_t^* are NID seasonal disturbances with zero mean and common variance σ_ω^2.

The statistical specification of the cycle, ψ_t, is given by the following:

[2] Notice that (1) differs from the specifications used for the new Keynesian and hybrid new Keynesian Phillips curves in that neither π_{t-1} and/or its expected one period ahead rate ($E_t \pi_{t+1}$) are present. However, Harvey (2011) has shown that under some assumptions about the autocorrelations in the errors, (1) is consistent with the new Keynesian Phillips curves.

$$\begin{bmatrix}\psi_t \\ \psi_t^*\end{bmatrix} = \rho_\psi \begin{bmatrix}\cos\lambda_c & \sin\lambda_c \\ -\sin\lambda_c & \cos\lambda_c\end{bmatrix}\begin{bmatrix}\psi_{t-1} \\ \psi_{t-1}^*\end{bmatrix} + \begin{bmatrix}\kappa_t \\ \kappa_t^*\end{bmatrix}, \quad t = 1,\ldots,T \tag{5}$$

where ρ_ψ (in the range $0 < \rho_\psi \leq 1$) is a damping factor; λ_c is the frequency, in radians, in the range $0 \leq \lambda_c \leq \pi$; κ_t , κ_t^* are NID disturbances with zero mean and common variance σ_κ^2.

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

$$\phi_{i,t} - \phi_{i,t-1} = \phi_{i,t-1} - \phi_{i,t-2} + u_{i,t} \quad u_{i,t} \sim N\ 0, \sigma_{u_i}^2 \tag{6}$$

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

3. Results

Table 1 shows results (with the STAMP software) for the US and Australia PCs for the period 1978Q1 – 2010Q3[3]. The results show that the models are well determined and the use of time-varying parameters is justified. When coefficients in Model A are allowed to vary over time (in Model B) the goodness of fits is better.[4]

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[3] We focus on the last 40 years because large outliers are detected by STAMP in the period before 1978. In addition, diagnostic tests are more robust if we start from 1978.

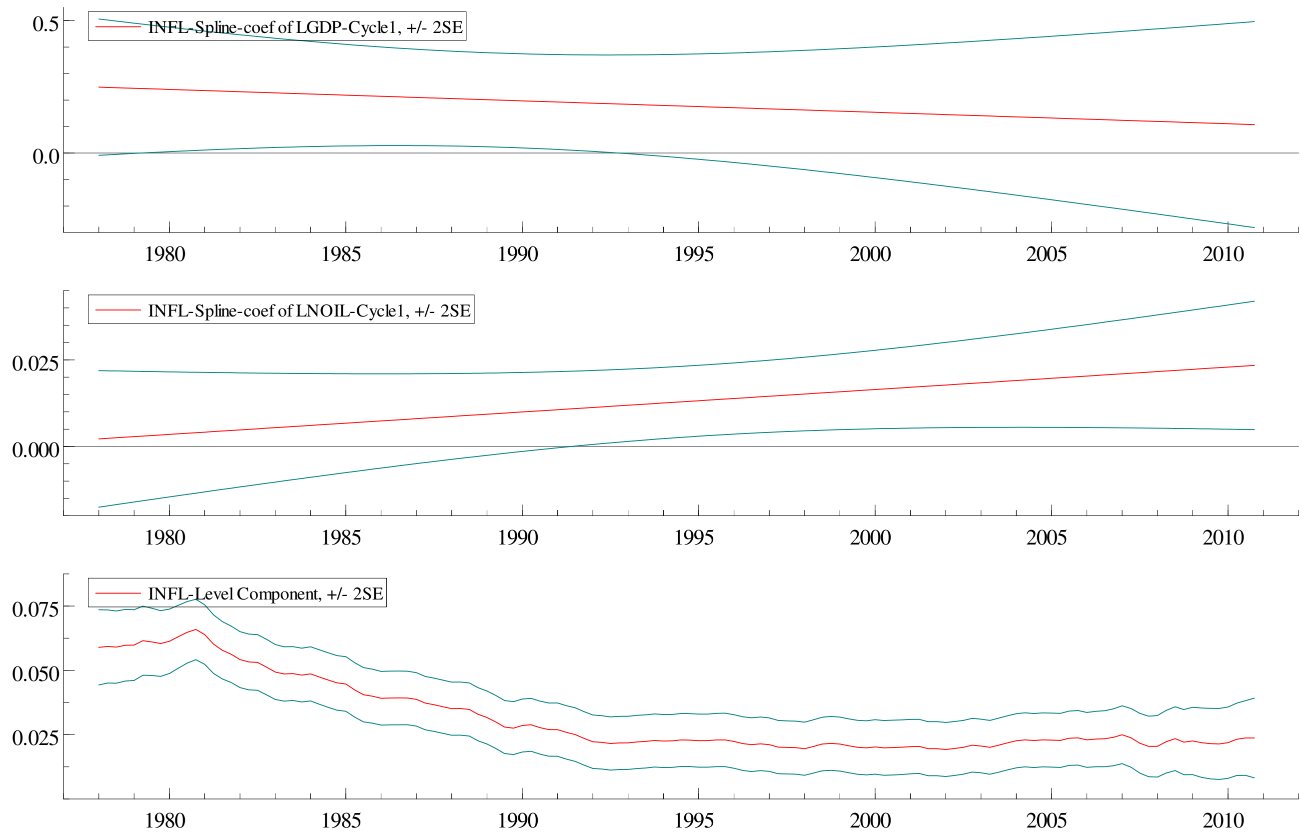
[4] The usual measures of goodness of fit are prediction error variance (PEV) and coefficient of determination (R^2).

Table 1: Phillips Curves estimation results of various models							
$$\pi_t = \mu_t + \psi_t + \gamma_t + \phi_1 y_t^{gap} + \phi_2 oil_t + \varepsilon_t$$ Model A							
	ϕ_1	ϕ_2	*PEV*	R^2	*Q*	*N*	*H*
USA	0.235**	0.013**	8.53E-05	0.320	0.128	0.018	0.941
Australia $^{\pm}$	0.456**	0.041**	8.10E-04	0.535	0.241	0.221	0.738
$$\pi_t = \mu_t + \psi_t + \gamma_t + \phi_{1,t} y_t^{gap} + \phi_{2,t} oil_t + \varepsilon_t$$ Model B							
	ϕ_1	ϕ_2	*PEV*	R^2	*Q*	*N*	*H*
USA	(see plots)	(see plots)	8.44E-05	0.339	0.173	0.012	0.962
Australia $^{\pm}$	(see plots)	(see plots)	7.00E-04	0.606	0.140	0.122	0.917

Note: $\pm$ In Australia seasonal component is not included. *** Significant at 1%; ** Significant at 5%. *PEV* = Prediction Error Variance. R^2 = Coefficient of determination ("seasonally" adjusted goodness of fit for USA since we have seasonal component). *N* = Normality statistic (Bowman-Shenton statistic with the correction of Doornik-Hansen). *H* = Heteroskedasticity test. *Q* = Box-Ljiung 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.

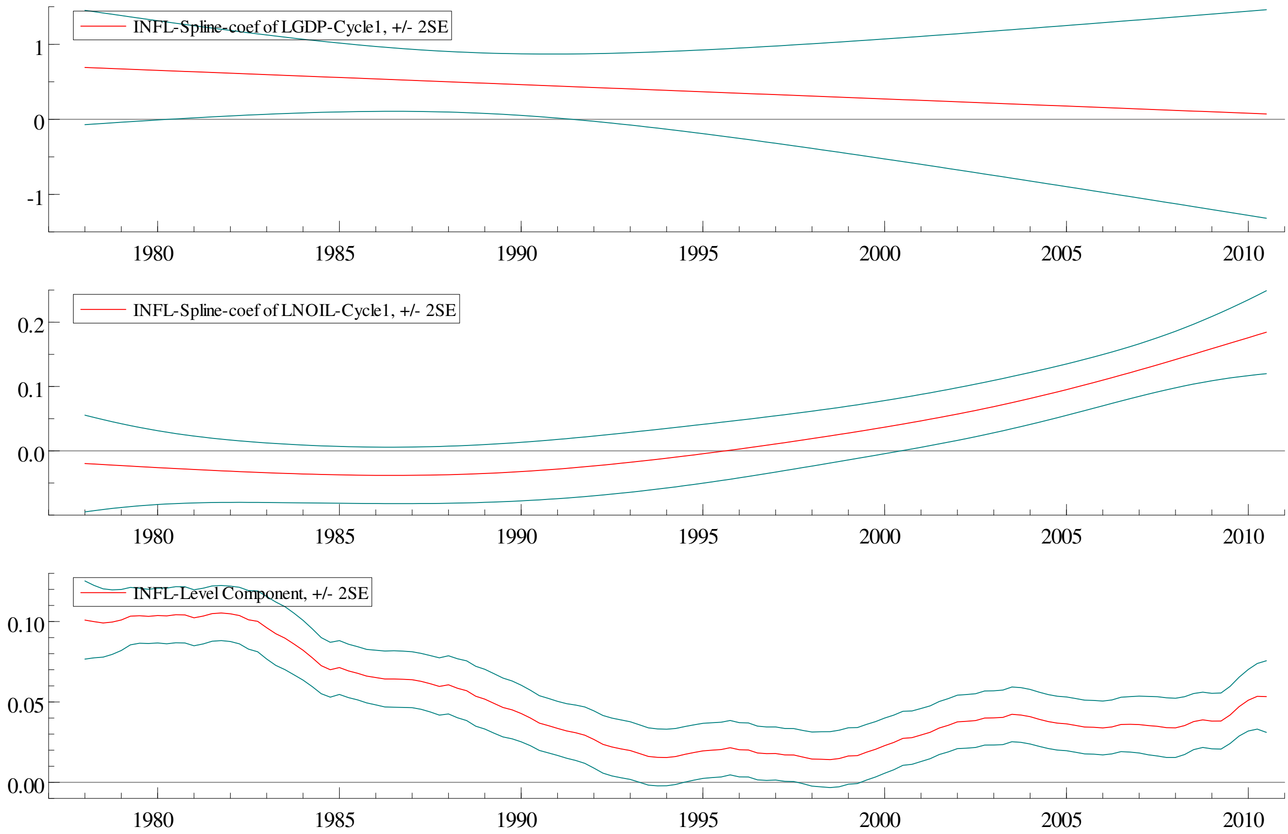
The time evolution of the coefficients of output gap and oil prices and the level component (all from Model B) with their two standard deviation bands are shown, respectively, in the three panels of Figure 1. It can be seen that the coefficient of GAP and the level component have decreased over time, which have positive effects for inflation policy. However, this is partly offset by the increase in the coefficient of oil prices. The decline in the level component is interpreted due to the decline in the core inflation because of explicit announcements of lower target rates of inflation by the Fed since the early 1980s. The decline in the coefficient of GAP, which has been more rapid since the 1990s, may be due the effects of globalization and the belated effects of other liberalization policies. The increase in the coefficient of oil prices is somewhat surprising because this implies that several energy saving policies seem to have had adverse effects. As our measure of inflation is based on the GDP deflator, it is likely that since real energy prices have increased more steeply since the late 1990s, the share of energy expenditure in the total private expenditure may have increased; see Edelstein and Kilian (2009). This may have caused this coefficient to show an increasing trend, implying that oil price will be an important determinant of future inflation.

Figure 1: Coefficients with 2SEs of the US Phillips Curve
Panel 1: GAP (ϕ_1); Panel 2: Oil Prices (ϕ_2); Panel 3: Level Component (μ)



In Australia the coefficient of GAP shows a declining pattern similar to US, which lends support to the argument that this is due to some common reasons like the effects of globalization (e.g., availability of cheap consumer goods from China etc.) and market liberalization policies. The decline in the level coefficient is similar up to the late 1990s, but this has shown a mild increase since then perhaps due to the introduction of a general goods and service tax in 2000 and the skill shortages cause by the high export demand for natural resources. The increase in the coefficient of oil is similar to the US pattern. Therefore, in Australia oil prices are also likely to play a significant role in inflation in the future.

Figure 2: Coefficients with 2SEs of the Australian Phillips Curve
Panel 1 GAP (ϕ_1); Panel 2: Oil Prices (ϕ_2); Panel 3: Level Component (μ)



4. Conclusions

This paper has used the unobservable components approach of Harvey (1989 and 2011) to estimate the Phillips curves for USA and Australia. Our specification included oil prices as an additional explanatory variable. We found that in both countries while the long term level coefficient of inflation (core inflation) and the coefficient of demand pressure have shown declining trends, the coefficient of oil prices has shown an increasing trend. The positive effects for inflation policy, due to the declines in the coefficients, seem to be due to a strong commitment by the monetary authorities to lower inflation targets and liberalization policies. The increase in the coefficient of the price of oil 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 the future rates of inflation. Therefore, policies to reduce the dependence on oil are important for future inflation policy.

Data Appendix

Definitions and Data Source: 1978Q1 – 2010Q3

Variable	Definition	Source
	Australian Data	
π	Annualized rate of change of GDP deflator: $\left(\ln p_t - \ln p_{t-1}\right) \times 4$	Reserve Bank of Australia.
y	Natural log of real GDP.	Reserve Bank of Australia.
y^{gap}	Output gap obtained through univariate trend-cycle decomposition: $y_t = \mu_t + \psi_t + \varepsilon_t, \quad \varepsilon_t \sim N\left(0, \sigma_\varepsilon^2\right), \quad t = 1, \ldots, T$ where μ_t is an integrated random walk, ε_t is white noise, and ψ_t is a time varying trigonometric cycle with frequency associated with the length of the cycle (in our case 3 as used by Harvey (2001)).	Authors' elaboration.
	US Data	
π	Annualized rate of change of GDP deflator: $\left(\ln p_t - \ln p_{t-1}\right) \times 4$	Federal Reserve Economic Data (FRED).
y	Natural log of real GDP.	Federal Reserve Economic Data (FRED).
y^{gap}	Output gap obtained through univariate trend-cycle decomposition.	Authors' elaboration.
oil	Cyclical component of natural log of oil price (West Texas Intermediate (US$/BBL)) obtained through a univariate trend-cycle decomposition as used for y^{gap}. Different specifications does not change our results.	Federal Reserve Economic Data (FRED).

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