THE RIMINI CENTRE FOR ECONOMIC ANALYSIS

WP 36-07

CHRISTOPHER MARTIN
School of Social Sciences
Brunel University, UK

and

COSTAS MILAS
Department of Economics,
Keele University, UK
and
The Rimini Centre for Economic Analysis, Rimini, Italy

"MONETARY POLICY AND THE HYBRID PHILLIPS CURVE"

The Rimini Centre for Economic Analysis
Legal address: Via Angherà, 22 – Head office: Via Patara, 3 - 47900 Rimini (RN) – Italy
www.rcfea.org - secretary@rcfea.org

Monetary Policy and the Hybrid Phillips Curve

Christopher Martin
School of Social Sciences
Brunel University
Uxbridge
Middlesex UB8 3PH

Costas Milas*
Department of Economics,
Keele University
Staffordshire, ST5 5BG
and
Rimini Centre for Economic Analysis, Rimini, Italy

September 2007

Abstract This paper argues that existing empirical models of interest rate rules are too simplistic. The hybrid Phillips curve implies that policymakers should respond to both current and expected future inflation rates, in contrast to existing models. We provide evidence that UK policymakers do this.

Keywords: optimal monetary policy; inflation persistence; Phillips curve
JEL Classification: C51, C52, E52, E58

1) Introduction

This paper argues that existing models of optimal monetary policy are too simplistic. They rely on the assumption that changes in interest rates only have a one-off effect on inflation. But the most influential model of the supply

* Corresponding author: Costas Milas, Department of Economics, Keele University, Keele, ST5 5BG, United Kingdom. Phone: +44 (0) 1782 583090. Fax: +44 (0) 1782 717577.
Email: c.milas@keele.ac.uk

side of the economy, the hybrid Phillips curve introduced by Gali and Gertler (1999), features inflation persistence. Since this implies that changes in interest rates will have persistent effects on inflation, the interest rate in the optimal monetary policy rule should respond to both current and expected future inflation rates. By neglecting the latter, the existing model is mis-specified.

This paper makes two contributions. First, we present a simple analysis of the optimal monetary policy rule when there is inflation persistence, highlighting the weaknesses in the existing conventional model. Second, we present empirical evidence. Using UK data that includes inflation forecasts published by the Bank of England, we estimate monetary policy rules and present evidence that monetary policymakers do respond to both current and expected future inflation rates. We show that allowing for this improves the fit of the model compared to the conventional model. We also show that there is a simple parametric restriction under which our model simplifies to the existing model; this restriction is rejected by the data. Section 2) of the paper develops our model, section 3) presents empirical evidence while section 4) summarises and concludes.

2) The Model

The aggregate demand curve is

(1) $$y_t = -\rho(i_t - E_t\pi_{t+1}) + E_t y_{t+1} + \varepsilon_t^d$$

where i is the nominal interest rate, ε_t^d is an i.i.d demand shock and ρ_i is a positive coefficient. The Phillips curve is

(2) $$\pi_t = (1-\theta)\pi_{t-1} + \theta\delta E_t \pi_{t+1} + \gamma mc_t + \varepsilon_t^s$$

This is the hybrid Phillips curve proposed by Gali and Gertler (1999), in which inflation depends on aggregate marginal cost as well as lagged and expected future inflation rates. We assume aggregate demand is proportional to marginal cost, so

(3) $$mc_t = \eta y_t$$

If policymakers choose the nominal interest rate at the beginning of period t on the basis of information available at the end of period t-1, then their optimisation problem is

(4) $$\text{Min}_{\{i_t\}} \ \Lambda = E_t \sum_{j=0}^{\infty} \delta^j L_{t+j}$$

subject to (1), (2) and (3) and where

(5) $$L_t = \frac{1}{2}\left(\pi_t - \pi^*\right)^2 + \frac{\lambda}{2} y_t^2 + \frac{\mu}{2}(i_t - i^*)^2 + \frac{\kappa}{2}(i_t - i_{t-1})^2$$

is a conventional per-period quadratic loss function, π* is the inflation target, i* is the equilibrium interest rate and λ, μ and κ are positive coefficients.

Solving the model under discretion, the first-order condition is

(6) $$\frac{d\Lambda}{di_t} = E_t\{-\rho\lambda y_t + \mu(i_t - i^*) + \kappa(i_t - i_{t-1}) - \rho\gamma\eta\left(\pi_t - \pi^*\right) - \rho\gamma\eta\delta(1-\theta)\left(\pi_{t+1} - \pi^*\right)$$
$$-\rho\gamma\eta\delta^2(1-\theta)^2\left(\pi_{t+2} - \pi^*\right) - \rho\gamma\eta\delta^3(1-\theta)^3\left(\pi_{t+3} - \pi^*\right)....\} = 0$$

which implies

(7) $$i_t = \frac{\kappa}{\mu+\kappa} i_{t-1} + \frac{\mu}{\mu+\kappa} i^* + \frac{\rho\lambda}{\mu+\kappa} E_t y_t + \frac{\rho\gamma\eta}{\mu+\kappa} E_t \sum_{j=0}^{\infty} (\delta(1-\theta))^j \left(\pi_{t+j} - \pi^*\right)$$

Existing models of optimal monetary policy uses the purely forward-looking New Keynesian Phillips curve; this is obtained when $\theta = 1$ in (2), in which case the policy rule in (7) simplifies to

(8) $$i_t = \frac{\kappa}{\mu+\kappa} i_{t-1} + \frac{\mu}{\mu+\kappa} i^* + \frac{\rho\lambda}{\mu+\kappa} E_t y_t + \frac{\rho\gamma\eta}{\mu+\kappa} E_t \left(\pi_t - \pi^*\right)$$

Comparison of (7) and (8) shows the implications of the hybrid Phillips curve for optimal monetary policy: interest rates respond to the discounted sum of current and expected future inflation rates, rather than just to the current inflation rate, as in the conventional model. The policy rule in (7) simply reflects the fact that interest rate changes at time t affect the inflation rate at time t, but also at times (t+1), (t+2), (t+3), etc. This analysis suggests that existing models of monetary policy may be incorrect because they ignore the impact of the sequence of expected future inflation rates on interest rates. Inclusion of this in empirical models should lead to improved estimates. We next consider whether this is the case.

3) Evidence

Expressing the model in terms of identifiable parameters, we estimate

(9) $$i_t = \phi i_{t-1} + (1-\phi)\{i^* + \beta_y E_t y_t + \beta_\pi E_t \sum_{j=0}^{\infty} (\beta_f)^j \left(\pi_{t+j} - \pi^*\right)\}$$

where $\phi = \dfrac{\kappa}{\mu+\kappa}$, $\beta_y = \dfrac{\rho\lambda}{\mu}$, $\beta_\pi = \dfrac{\rho\gamma\eta}{\mu}$ and $\beta_f = \delta(1-\theta)$; we have followed the literature (eg Clarida et al, 1999) in expressing the weights on output and inflation as the long-run responses, net of interest rate smoothing. If there is no inflation persistence, then $\beta_f = 0$ and our model simplifies to the existing model. We could of course obtain more structural estimates by joint estimation of (1), (2), (3) and (9), but this is beyond the scope of this short paper.

We use UK data for 1992Q4-2007Q1, covering the period of inflation targeting. We use the 3-month Treasury bill rate as the nominal interest rate (this has a close relationship with the various interest rate instruments used over this period; see Nelson, 2003 and Adam et al., 2005). For inflation we use the rate targeted by the Bank of England: the annual change in the retail price index excluding mortgage interest payment (RPIX) until 2003q4, thereafter the annual change in the Consumer Price Index. We use two alternative published forecasts of this variable for up to eight quarters ahead published by the Bank of England; the first assumes constant interest rates over the forecast period, while the second (which is only available from 1998Q1) assumes interest rates follow market expectations (see Britton et al, 1998). We use two measures of the output gap series: the difference between final output and a HP trend and the residuals from a regression of final output on a quadratic trend.

Estimates of (9) are presented in columns (i)-(iii) of table 1) (where we truncate the infinite sum after 8 periods). Column (i) uses a constant interest rate forecast of inflation and uses the Hodrick-Prescott filter (1997) in constructing the output gap. Column (ii) uses the alternative measure of the output gap while column (iii) uses the alternative forecast of inflation. The estimates in each column are quite similar, the best fit being obtained in column (iii). The estimates of β_y and β_π are significant and exceed unity. The estimates of β_f are all significant and vary between 0.11 and 0.17. The model in (9) simplifies to the existing model if the restriction $H_0: \beta_f = 0$ is accepted. It is clearly rejected. We also note that there is no evidence of a break during the sample period, which is important as the target shifted from RPIX to CPI inflation in 2003Q4 (we also note that some other papers (Favero and Rovelli, 2003, Aguiar and Martins, 2005) have estimated policy rules in which interest rates respond to more than one inflation rate; however these papers do not test this against the conventional model and do not relate this issue to the hybrid Phillips curve). Assuming δ is close to unity, our estimates suggest a relatively low, but nevertheless significant, degree of persistence in the Phillips curve, which is consistent with the estimates in Gali and Gertler (1999). Taking the model in column (iii), our estimates imply the weight on current inflation is 1.29, the weight on inflation in period (t+1) is 0.15 and that the weight on periods further ahead is small. Columns (iv) and (v) present estimates of the conventional model in (8) using our alternative measures of the output gap. The estimates of the included parameters are similar to those in earlier columns, but the fit of the model is worse, providing further empirical support for our model.

We estimated other versions of the model (not reported but available form the authors on request). These included models that used actual rather than forecast future inflation rates, models that used expected future rather than current output gaps and models that allowed for a delay in the impact of interest rates on inflation. Estimates of these models were broadly similar but inferior to those reported in table 1).

4) Conclusions

This paper has argued that existing empirical models of optimal monetary policy rules are over-simplified. Persistence of inflation in the Phillips curve, for which there is strong empirical support suggests interest rates should respond to the discounted sum of current and expected future inflation rates, rather than just to the current inflation rate, as in the conventional model. We have provided empirical evidence that suggests this is the case.

Our work is clearly preliminary. A more detailed study would estimate the policy rule, Phillips curve, aggregate demand equation and the relationship between marginal cost and the output gap as a system, allowing the structural parameters to the identified. However we would not expect this extension to affect our main conclusion.

Table 1

Estimates of (9)

		(i)	(ii)	(iii)	(iv)	(v)
Sample		1992Q4-2007Q1	1992Q4-2007Q1	1998Q1-2007Q1	1992Q4-2007Q1	1992Q4-2007Q1
Inflation forecast		Constant interest rates	Constant interest rates	Expected interest rates		
Output gap		HP	QT	HP	HP	QT
ϕ		0.87 (0.05)	0.86 (0.06)	0.83 (0.05)	0.87 (0.05)	0.89 (0.05)
β_y		1.81 (0.60)	1.32 (0.60)	2.40 (0.68)	2.45 (1.16)	1.53 (1.02)
β_π		1.33 (0.60)	1.54 (0.62)	1.29 (0.60)	1.74 (1.12)	1.29 (1.40)
β_f		0.11 (0.04)	0.17 (0.05)	0.12 (0.04)		
Regression standard error		0.37	0.39	0.34	0.40	0.39
Parameter stability		0.30	0.31	0.31	0.30	0.28

Notes:

1. Standard errors in parentheses.
2. Estimation by GMM; instruments comprise a constant, and 3 lags of the interest rate, inflation and the output gap.
3. Inflation forecast: “Constant interest rates” denotes use of inflation forecasts that assume constant interest rates, while “expected interest rates” denotes forecasts that use market expectations of interest rates.
4. Output gap: “HP” denotes proportional deviation of GDP from its Hodrick-Prescott trend; “QT” denotes deviation from fitted values from a regression of GDP on a quadratic trend.
5. Parameter stability test: (p-value; see Lin and Teräsvirta, 1994).
6. All models include an estimated intercept (not reported).

References

Adam, C., D. Cobham and E. Girardin (2005). Monetary frameworks and institutional constraints: UK monetary policy reaction functions, 1985-2003, Oxford Bulletin of Economics and Statistics, 67, pp. 497-516.

Aguiar, A. and M. Martins (2005). Testing for asymmetries in the preferences of the euro-area monetary policymaker, mimeo, University of Porto.

Britton, E., P. Fisher and J. Whitley (1998). The Inflation Report Projections: Understanding the Fan Chart, Bank of England Quarterly Bulletin, February, pp. 30-37.

Clarida, R, J. Gali, and M. Gertler (1999). The Science of Monetary Policy: A New Keynesian Perspective, Journal of Economic Literature, 37, pp. 1661-1707.

Favero, C. and R. Rovelli (2003). Macroeconomic stability and the preferences of the Fed. A formal analysis, Journal of Money, Credit and Banking, 35, pp. 545-556.

Gali, J. and M. Gertler (1999). Inflation dynamics: a structural econometric analysis, Journal of Monetary Economics, 44, 195-222.

Hodrick, R.J. and E.C. Prescott (1997). Postwar U.S. business cycles: An empirical investigation, Journal of Money, Credit, and Banking, 29, pp 1–16.

Lin, C-F.J., and T. Teräsvirta (1994). Testing the Constancy of Regression Parameters Against Continuous Structural Change, Journal of Econometrics, 62, 211-228.

Nelson, E. (2003). UK Monetary Policy 1972–97: A Guide Using Taylor Rules, in P. Mizen (ed.), Central Banking, Monetary Theory and Practice: Essays in Honour of Charles Goodhart, Volume One. Cheltenham, UK: Edward Elgar, 2003.