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Abstract

This paper examines the validity of Rudd and Whelan's (2006) critiques of Gali and Gertler's (1999) hybrid Phillips curve (HYPC) by re-estimating the HYPC using full information maximum likelihood (FIML). We also estimate HYPC with the constraint that the weights for the sum of forward looking and backward looking expectations should be unity. Our results support Rudd and Whelan's conclusion that the weight for forward looking expectations is insignificant.

Keywords: New Keynesian Phillips Curve, Price Rigidities, FIML Estimation

JEL: E31, E32, C22

1. Introduction

Empirical studies on the new Keynesian Phillips curve (NKPC) reached different conclusions on the relative importance of forward looking and backward looking expectations. It is important to re-examine this difference because the real and nominal effects of policy shocks depend on the relative importance of the weights for forward and backward looking expectations (weights hereafter). In an influential paper Gali and Gertler (1999) have developed a hybrid Phillips curve (HYPC) to estimate these weights and found that although the weight for backward expectations is significant, it is relatively small. This implies that the degree of persistence in inflation is small, and, therefore, real effects of policy shocks will also be small.[1] According to Rudd and Whelan (2007), there is near consensus among the new Keynesian economists (NKEs) that the HYPC, with a large weight for forward looking expectations and a smaller weight for backward looking expectations, provides a sensible and empirically plausible theoretical framework to analyse inflation.

In another influential paper, Rudd and Whelan (2006) have argued that the Gali and Gertler HYPC is inappropriate for estimating the weights because the implied expectations are not strictly rational as they are not model consistent. Using the closed form solutions for the Gali and Gertler HYPC, to get model consistent rational expectations, they found that the weight for forward looking expectations is insignificant. Although the Gali and Gertler methodology may not be appropriate, Rudd and Whelan's specifications also have limitations because their reduced form weights do not sum to unity. It is necessary, therefore, to re-estimate these weights with the constraint that they should add to unity. This is the main objective of this paper and is structured as follows. Section 2 presents specifications of the HYPC. Section 3 discusses our empirical results and Section 4 concludes.

[1] This implies, for example, that unemployment rate will increase only by a small amount even if the anti-inflationary deflationary policy shock is large. On the other hand, if inflation is highly persistent, this increase would be large and large deflationary shocks are costly.

2. Specifications

The Gali and Gertler HYPC is:

$$\pi_t = (1-\theta)\pi_{t-1} + \theta E_t[\pi_{t+1}] + \alpha_y y_t \tag{1}$$

where $\pi =$ rate of inflation, $y =$ a proxy for real marginal costs, e.g., the share of labour income (s) and $\theta =$ weight for forward expectation of inflation. This can be estimated with the generalised method of moments (GMM) by replacing $E_t[\pi_{t+1}]$ with π_{t+1}. However, as Rudd and Whelan point out, this does not give model consistent rational expectations. Rudd and Whelan's closed form solutions, based on model consistent rational expectations, are different when $\theta \le 0.5$ and $\theta > 0.5$. The structural closed form solutions, with their reduced forms, are:

$$\begin{aligned} \pi_t &= \frac{\theta}{1-\theta}\pi_{t-1} + \frac{\gamma}{\theta}\sum_{k=0}^{\infty} E_t y_{t+k} \\ &= \mu_2 \pi_{t-1} + \mu_1 \sum_{k=0}^{\infty} E_t y_{t+k} \end{aligned} \tag{2}$$

when $\theta > 0.5$.

$$\begin{aligned} \Delta\pi_t &= \frac{\gamma}{1-\theta}\sum_{k=0}^{\infty}\left(\frac{\theta}{1-\theta}\right)^k E_t y_{t+k} \\ &= \lambda_1 \sum_{k=0}^{\infty} \lambda_2^k E_t y_{t+k} \end{aligned} \tag{3}$$

when $\theta \le 0.5$.

where the reduced form weights for forward looking expectations are μ_1 and λ_1 and for backward looking expectations μ_2 and λ_2. Rudd and Whelan estimated (2) and (3) without the constraint these weights sum to unity. For example their estimates, in Table 2, for of λ_1 and λ_2 sum to only 0.653. Similarly, in Table 4, the weights in (2) only sum to 0.502. Our constrained specifications of (2) and (3) are:

(4) $$\pi_t = (1-\mu_1)\pi_{t-1} + \mu_1 \sum_{k=0}^{\infty} E_t y_{t+k}$$
when $\theta > 0.5$.

and

(5) $$\Delta\pi_t = \lambda_1 \sum_{k=0}^{\infty} (1-\lambda_1)^k E_t y_{t+k}$$
when $\theta \leq 0.5$.

3. Empirical Results

To conserve space and avoid problems in selecting the instrumental variables, we used full information maximum likelihood (FIML), instead of GMM, for estimation.[2] For comparisons we estimated the Gali and Gertler specification in equation (1) with alternative proxies for y, the driving force of inflation, with the output gap (GAP), share of labour income (s) and the probability of placement for newly unemployed workers (JFP). GAP gave the best results and this is shown below.

(6) $$\pi_t = \underset{(0.04)***}{0.8335}\pi_{t-1} + \underset{(0.04)***}{0.1665}E_t[\pi_{t+1}] + \underset{(0.03)***}{0.4446}GAP_t$$

Standard errors are below the coefficients in the parentheses and *** indicates significance at the 1% level. The implied discount factor to discount future profits is 0.969, which implies a discount rate of 3.21% and this is plausible. Unlike the Gali and Gertler GMM estimates, our estimates with the updated data and FIML imply that backward looking expectations are almost five time more important than forward looking expectations. As noted in footnote 2 above, while our estimates are free from the instrumental variable selection bias, the

[2] There are some important problems in selecting the instrumental variables in GMM for the forward looking expectations. For example, if the selected instruments include some variables that have direct effects on inflation, e.g., output gap, price of material inputs such as commodity and oil prices and lagged inflation rates etc., then the coefficient of forward expectations is likely to be large and significant even if the forward looking expectations have significant effects on inflation. This criticism was originally made by Rudd and Whelan (2007) against Gali and Gertler (1999) because their instrumental variables include such variables.

instrumental variables selected by Gali and Gertler are likely to overestimate the weight for forward looking expectations and underestimate the weight for backward looking expectations.

Using GAP as the driving force, FIML estimates of the unconstrained and constrained reduced form equations (2) to (5) are given in Table 1.

Table 1
FIML Estimates of the US Hybrid Phillips Curve
1960:Q1 to 2010:Q1

Equation	μ_1	μ_2	λ_1	λ_2
Eq (2)	-0.0101 (0.01)	0.9959 ($0.85E^{-02}$) ***		
Eq (3)	---	---	-0.3347 (0.12)	-0.3780 (0.47)
Constrained Estimates				
Eq (4)	$-0.8513E^{-03}$ ($0.85E^{-02}$)	1.0009 ($0.85E^{-02}$) ***		
Eq (5)	---	---	-0.0102 ($0.60E^{-02}$) *	1.0102 ($0.60E^{-02}$) ***

Notes: Standard errors are in the parentheses below the coefficients. *** signifies significance at 1% level and * signifies significance at 10% level. Four forward values of GAP are used in the estimates and increasing these terms has given similar results.

Compared to the estimates of the Gali and Gertler equation, estimates of the Rudd and Whelan equations, especially estimates of the unconstrained equation (3), are somewhat less than impressive. In equation (3) both weights are negative and insignificant. In the other three equations the weight for backward looking expectation is almost unity, implying that forward looking expectations do not seem to have any effect on the dynamics of inflation. However, like in the Rudd and Whelan estimates, the weights for the forward looking expectations are insignificant and have the wrong signs. Broadly, our results support Rudd and Whelan's general conclusion that forward looking expectations are insignificant in the inflation dynamics. Even estimates in the Gali and Gertler equation are supportive of the conclusion that forward looking expectations play a smaller role in the dynamics of inflation.

A plausible explanation for these differences is as follows. While the Gali and Gertler specification seems to be more applicable for the short to medium terms, the Rudd and Whelan specifications, based on the closed form solutions, may be more appropriate for longer periods. It is also likely that firms may not form model consistent expectations because there is no correct model for explaining the dynamics of inflation. Furthermore, as Rudd and Whelan have noted, inertia in the formation of expectations, due to bounded rationality, may be more important than inertia in adjusting prices by firms.

4. Conclusions

This paper estimated the US NKPC for the period 1960Q1 to 2010Q1. Our estimates with the Gali and Gertler HYPC showed that forward looking behaviour plays a relatively minor role in the dynamics of inflation. Estimates with the Rudd and Whelan specifications show that forward looking expectations have no role at all in the dynamics of inflation. Results of this paper support the Rudd and Whelan conclusion that a traditional specification of the Phillips curve, which depends on the output gap and the past rates of inflation is adequate to explain the dynamics of inflation. Therefore, one would expect that policy interventions to have significant real effects. A model in which inertia to adjust expectations plays a more important role, such as in Mankiw and Reis (2003), may explain observed facts better than the new Keynesian models based on inertia in price adjustments.[3] Thus, this paper supports

[3] A similar friction in forming rational expectations was used by Rao (1991). His justification is that the information set for rational agents should include the fact that markets may not reach equilibrium within the unit

the observation of Rudd and Whelan (2007) that there are a number of reasons to be sceptical about the new Keynesian framework that has became the new benchmark inflation modelling and in particular its corner stone of forward looking expectations.

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time period. This implies that $E[\pi_t] = -\theta(\pi_{t-1} - \pi_t^*) + \pi_{t-1}$, where asterisk denotes equilibrium value and $0 \leq \theta \leq 1$ is the adjustment coefficient taking a value of one when there is no sluggishness in the adjustment of expectations.

Data Appendix

All series are quarterly data from the United States from 1960Q1 to 2010Q1. We use core CPI as our measure of inflation and this excludes prices of food and energy.

Variable	Definition	Source
π_t	π_t is measured as $\ln\left[\frac{p_t}{p_{t-4}}\right]$ using core CPI. Core CPI - Consumer Price Index (All Items Less Food and Energy), Index 1982-1984=100.	Bureau of Labor Statistics (BLS).
y and GAP	Output Gap (Nonfarm Business Sector Output, Index 1992=100), using the Hodrick-Prescott filter with a smoothing parameter of 1600.	Bureau of Labor Statistics (BLS).

References

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

Mankiw, Gregory and Ricardo Reis (2002), "Sticky Information Versus Sticky Prices: A Proposal to Replace The New Keynesian Philips Curve", *The Quarterly Journal of Economics*.

Rao, B. B. and Srivastava, V. K. (1991), "A Disequilibrium Model of Rational Expectations for the U.K.", *Economic Journal*, 101: 877-86.

Rudd, Jeremy, and Karl Whelan (2006), "Can Rational Expectations Sticky-Price Models Explain Inflation Dynamics?" *American Economic Review* 96 (March): 303–20.

Rudd, Jeremy, and Karl Whelan (2007), "Modelling Inflation Dynamics: A Critical Review of Recent Research." *Journal of Money, Credit, and Banking* 39: 155–70.