Economics Letters 156 (2017) 53–57

Contents lists available at ScienceDirect

Economics Letters

journal homepage: www.elsevier.com/locate/ecolet

Assessment of hybrid Phillips Curve specifications

Marcelle Chauvet [a], Joonyoung Hur [b], Insu Kim [c,*]

[a] Department of Economics, University of California—Riverside, United States
[b] Department of Economics, Hankuk University of Foreign Studies, Republic of Korea
[c] Department of Economics, Sungkyunkwan University, Seoul, Republic of Korea

HIGHLIGHTS

- The first-difference of inflation negatively depends on its own lag.
- The stylized fact rejects the forward-looking NKPC and its hybrid variant with a lag of inflation.
- We show that the stylized fact can be reconciled with the hybrid NKPC with lags of inflation.
- Firm's forward-looking behavior is relatively more important than backward-looking behavior.

ARTICLE INFO

Article history:
Received 26 January 2017
Received in revised form
12 April 2017
Accepted 16 April 2017
Available online 18 April 2017

JEL classification:
E31

Keywords:
Inflation
Sticky price
Hybrid Phillips Curve
Forward-looking
Backward-looking indexation
Lags of inflation

ABSTRACT

Rudd and Whelan (2006) document evidence that the first-difference of inflation negatively depends on its own lag, and highlight that sticky price models emphasizing the role of firms' forward-looking pricing behavior cannot be reconciled with the stylized fact. We show that the puzzling negative dependence of the first-difference of inflation on its own lag is consistent with the prediction of the hybrid New Keynesian Phillips Curve (NKPC) with lags of inflation, whereas, as it is argued, it is inconsistent with the prediction of both the purely forward-looking NKPC and its hybrid variant with a lag of inflation. Our theoretical results show that the negative dependence appears only when firms' forward-looking pricing behavior is relatively more important than backward-looking behavior in determining inflation dynamics.

1. Introduction

The New Keynesian Phillips Curve (NKPC) is a centerpiece of dynamic stochastic general equilibrium (DSGE) models for the study of monetary policy and business cycle fluctuations. However, Rudd and Whelan (2006) document evidence that the first-difference of inflation negatively depends on its own lag, and highlight that the puzzling negative dependence is an important feature that is absent from the hybrid NKPC with a lag of inflation.[1] In addition, this feature is also not consistent with the purely forward-looking NKPC in which current inflation does not rely on lags of inflation.

This article investigates whether the stylized fact can be reconciled with an alternative hybrid NKPC with lags of inflation, instead of a single lag of inflation. To this end, we derive the closed-form solution of the alternative hybrid model, and find that the first-difference of inflation is determined by its lagged value and expected values of future output. Interestingly, the coefficient governing the relationship between the first-difference of inflation and its own lag is negative when firms' forward-looking pricing behavior is relatively more important than backward-looking behavior, while it is positive when the opposite is true. Our empirical results show that the stylized fact is consistent with the prediction of the hybrid model with lags of inflation, while, as Rudd and Whelan (2006) point out, it is inconsistent with the prediction of the hybrid NPC with a lag of inflation. We also find

* Corresponding author.
E-mail addresses: chauvet@ucr.edu (M. Chauvet), joonyhur@gmail.com (J. Hur), insu.kim@skku.edu (I. Kim).

[1] Rudd and Whelan (2006) find that the stylized fact is robustly observed even after commodity price and measurement error are controlled for in their regression analysis. See Rudd and Whelan (2006) for a detailed discussion about this issue.

http://dx.doi.org/10.1016/j.econlet.2017.04.018
0165-1765/Published by Elsevier B.V.

that expected values of future output play an important role in determining inflation dynamics. This evidence is consistent with the prediction of the closed-form solution of the hybrid model with lags of inflation. Overall, we find that the hybrid model with lags of inflation is supported by data.

2. Inflation dynamics and hybrid NKPC

The aim of this article is to investigate whether the stylized fact documented by Rudd and Whelan (2006) can be reconciled with a hybrid NKPC emphasizing the role of firms' forward-looking pricing behavior in accounting for inflation dynamics. To this end, we employ a hybrid model given by

$$\pi_t - \kappa\bar{\pi}_t = \beta E_t\left(\pi_{t+1} - \kappa\bar{\pi}_{t+1}\right) + \eta y_t + \vartheta_t \tag{1}$$

where $\bar{\pi}_t \equiv \tau_1\pi_{t-1} + \tau_2\pi_{t-2}$ and $\tau_1 + \tau_2 = 1$. π_t and y_t denote the inflation rate and output, respectively. The term ϑ_t represents an exogenous innovation to inflation. The parameter β is the discount factor, and the parameter $\kappa \in [0, 1]$ captures the degree of indexation to lags of inflation.[2] The hybrid model nests the purely forward-looking NKPC ($\kappa = 0$) and the hybrid NKPC with a lag of inflation ($\tau_2 = 0$) employed in Fuhrer (2009), Bekaert et al. (2010), and many others.

Rearranging (1) yields

$$\pi_t = \frac{\beta}{1+\beta\kappa\tau_1}E_t\pi_{t+1} + \frac{\kappa\left(\tau_1 - \beta\tau_2\right)}{1+\beta\kappa\tau_1}\pi_{t-1} + \frac{\kappa\tau_2}{1+\beta\kappa\tau_1}\pi_{t-2} + \frac{\eta}{1+\beta\kappa\tau_1}y_t + \epsilon_t^{\pi} \tag{2}$$

where $\epsilon_t^{\pi} \equiv \vartheta_t/\left(1+\beta\kappa\tau_1\right)$. (2) can be written as

$$\pi_t = \theta E_t\pi_{t+1} + \theta_1\pi_{t-1} + \theta_2\pi_{t-2} + \lambda y_t + \epsilon_t^{\pi} \tag{3}$$

where $\theta \equiv \frac{\beta}{1+\beta\kappa\tau_1}$, $\theta_1 \equiv \frac{\kappa(\tau_1-\beta\tau_2)}{1+\beta\kappa\tau_1}$, $\theta_2 \equiv \frac{\kappa\tau_2}{1+\beta\kappa\tau_1}$, and $\lambda \equiv \frac{\eta}{1+\beta\kappa\tau_1}$. We interpret ϵ_t^{π} as a supply shock, which follows an AR(1) process, $\epsilon_t^{\pi} = \delta^{\pi}\epsilon_{t-1}^{\pi} + v_t^{\pi}$ with $v_t^{\pi} \sim N(0, \sigma_{\pi}^2)$. The parameter β is restricted to be one in the remainder of this article so that (3) satisfies $\theta + \theta_1 + \theta_2 = 1$ as in Rudd and Whelan (2006).

This article differs from Rudd and Whelan (2006) in that we provide the closed-form solution of the hybrid model with lags of inflation, instead of a single lag of inflation. Using (1) instead of (3), we can easily demonstrate that the change in inflation, $\Delta\pi_t$, has a relationship with its own lag under the two indexation models: the full indexation model ($\kappa = 1$) and the partial indexation model ($\kappa \in (0, 1)$). Turning to the full indexation model with the restriction of $\beta = 1$ (equivalently, $\theta + \theta_1 + \theta_2 = 1$), iterating (1) in the forward direction delivers

$$\pi_t - \left(\tau_1\pi_{t-1} + \tau_2\pi_{t-2}\right) = \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \sum_{k=0}^{\infty}E_t\vartheta_{t+k}. \tag{4}$$

Rearranging (4) gives rise to

$$\Delta\pi_t - (\tau_1 - 1)\Delta\pi_{t-1} = \eta\sum_{k=0}^{\infty}E_t y_{t+k} + (1+\tau_1)\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi} \tag{5}$$

where $\epsilon_{t+k}^{\pi} = \vartheta_{t+k}/\left(1+\tau_1\right)$. We hold $\theta = \frac{1}{1+\tau_1}$ when $\kappa = 1$ and $\theta + \theta_1 + \theta_2 = 1$. Therefore, (5) can be written as

$$\Delta\pi_t = \left(\frac{1-2\theta}{\theta}\right)\Delta\pi_{t-1} + \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \frac{1}{\theta}\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}. \tag{6}$$

Interestingly, (6) implies that the first-difference of inflation, $\Delta\pi_t$, negatively depends on its own lag when firms' forward-looking pricing behavior is more important than backward-looking behavior ($\theta > 1/2$). On the other hand, when the role played by backward-looking behavior is dominant ($\theta < 1/2$), the model predicts a positive relationship of $\Delta\pi_t$ with $\Delta\pi_{t-1}$.

We now turn to the partial indexation model with the restriction of $\beta = 1$ (equivalently, $\theta + \theta_1 + \theta_2 = 1$). Iterating (1) forward yields

$$\pi_t - \kappa\left(\tau_1\pi_{t-1} + \tau_2\pi_{t-2}\right) = \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \sum_{k=0}^{\infty}E_t\vartheta_{t+k}. \tag{7}$$

Rearranging (7) results in

$$\Delta\pi_t = (\kappa\tau_1 - 1)\Delta\pi_{t-1} + (\kappa - 1)\pi_{t-2} + \eta\sum_{k=0}^{\infty}E_t y_{t+k} + (1+\kappa\tau_1)\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}x \tag{8}$$

where $\epsilon_{t+k}^{\pi} = \vartheta_{t+k}/\left(1+\kappa\tau_1\right)$. Using the conditions of $\theta = \frac{1}{1+\kappa\tau_1}$, $\theta_1 = \frac{\kappa(\tau_1-\tau_2)}{1+\kappa\tau_1}$, $\theta + \theta_1 + \theta_2 = 1$, (8) can be written as

$$\Delta\pi_t = \left(\frac{1-2\theta}{\theta}\right)\Delta\pi_{t-1} + \left(\frac{2-3\theta-\theta_1}{\theta}\right)\pi_{t-2} + \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \frac{1}{\theta}\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}. \tag{9}$$

When $\theta > 1/2$, the model yields a negative relationship of the first-difference of inflation with its own lag. By contrast, the model with $\theta < 1/2$ predicts positive autocorrelation of $\Delta\pi_t$.[3] Thus, we find that the model properties hold for both the partial and full indexation model.[4]

The summation term, $\sum_{k=0}^{\infty}E_t y_{t+k}$, that appears in (6) and (9) makes it difficult to estimate the full and partial indexation models. To avoid this problem, we define the summation term as $X_t \equiv \sum_{k=0}^{\infty}E_t y_{t+k}$ and introduce an equation governing the dynamics of X_t for estimation as follows

$$X_t = E_t X_{t+1} + y_t. \tag{10}$$

Notice that iterating X_t forward results in $X_t = \sum_{k=0}^{\infty}E_t y_{t+k}$. The summation term $\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}$ of (6) and (9) can be written as $\frac{\epsilon_t^{\pi}}{1-\delta^{\pi}}$ because the supply shock follows the AR(1) process. Thus, the indexation models, (6) and (9), can be expressed as

$$\Delta\pi_t = \left(\frac{1-2\theta}{\theta}\right)\Delta\pi_{t-1} + \eta X_t + \frac{\epsilon_t^{\pi}}{\theta\left(1-\delta^{\pi}\right)} \tag{11}$$

$$\Delta\pi_t = \left(\frac{1-2\theta}{\theta}\right)\Delta\pi_{t-1} + \left(\frac{2-3\theta-\theta_1}{\theta}\right)\pi_{t-2} + \eta X_t + \frac{\epsilon_t^{\pi}}{\theta\left(1-\delta^{\pi}\right)}, \tag{12}$$

respectively.

---

[2] (1) can be derived under the assumption that only a fraction of firms optimize their prices every period and the remaining firms who cannot optimize their prices index them to $\bar{\pi}_t = \tau_1\pi_{t-1} + \tau_2\pi_{t-2}$.

[3] In contrast to (9), the parameter θ_1 does not appear in (6). This is because there is a one-to-one relationship between θ and θ_1 in the full indexation model due to the restriction of $\kappa = 1$. Notice that we hold $\theta_1 = 2 - 3\theta$ when the parameter κ is restricted to be one.

[4] The partial indexation model with $\tau_2 = 0$ can be written as $\pi_t = \frac{1-\theta}{\theta}\pi_{t-1} + \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \frac{1}{\theta}\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}$. Rearranging this equation results in $\Delta\pi_t = \left(\frac{1-\theta}{\theta} - 1\right)\pi_{t-1} + \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \frac{1}{\theta}\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}$. This model suggests that $\Delta\pi_t$ is predicted by π_{t-1} rather than $\Delta\pi_{t-1}$. The full indexation model with $\tau_2 = 0$ (equivalently, $\theta = 1/2$) implies that the first-difference of inflation can be expressed as $\Delta\pi_t = \eta\sum_{k=0}^{\infty}E_t y_{t+k} + \frac{1}{\theta}\sum_{k=0}^{\infty}E_t\epsilon_{t+k}^{\pi}$. This model also predicts that $\Delta\pi_{t-1}$ does not have any contribution to $\Delta\pi_t$.