Galí and Gertler (1999) *JME*

**INFLATION DYNAMICS: A STRUCTURAL ECONOMETRIC ANALYSIS**

Overview

Features:

1. Use a marginal cost measure instead of the output gap as the driving variable (this accounts directly for gains in productivity).
2. Allows backward and forward looking behavior simultaneously.
3. The structural parameters of the model are estimated econometrically.
Results

1. Real marginal costs are statistically and economically significant determinants of inflation.
2. Forward looking behavior is dominant – nearly 60-80% of the firms behave this way.
3. Backward looking behavior is statistically significant but quantitatively less important.
4. The average duration a price is fixed is about 1 year, long but consistent with survey data.

These results support the “new Phillips curve”.

Real marginal costs tend to lag output over the cycle rather than move contemporaneously – in contrast to standard sticky price models.
Inflation inertia may be due to sluggish adjustment of real marginal costs to movements in output.

The New Phillips Curve

The Baseline Model

• firms are monopolistically competitive
• there is some price-adjustment friction (e.g. Taylor, 1980).
• however, the price rule is time-dependent and derived at the firm level rather than in the aggregate.
• to simplify aggregation, use Calvo (1983) pricing, i.e., \( 1 - \theta \) probability of adjusting prices in period \( t \), \( \theta \) of not adjusting.
• Average time the price is fixed: \( 1/(1 - \theta) \)
Accordingly,

\[ p_t = \theta p_{t-1} + (1 - \theta) p_t^* \]

in % deviations from steady state. Let \( mc_t^n \) be the firm’s marginal cost (in % dev. from s-s) then, from Calvo (1983)

\[ p_t^* = (1 - \beta \theta) \sum_{k=0}^{\infty} (\beta \theta)^j E_t \{ mc_{t+k}^n \} \]

In setting prices at time \( t \), the firm takes into account the expected future path of nominal marginal cost, given the likelihood that the price will remain fixed for multiple periods.

Combining equations:

\[ \pi_t = \lambda mc_t + \beta E_t \{ \pi_{t+1} \} \text{ with } \lambda = \frac{(1 - \theta)(1 - \beta \theta)}{\theta} \]
In other words:

$$\pi_t = \lambda \sum_{k=0}^{\infty} \beta^k E_t \{mc_{t+k}\}$$

Under certain conditions (see paper), there is an approximate relation between the output gap and marginal cost given by:

$$mc_t = kx_t$$

which combined with previous expressions, delivers

$$\pi_t = \lambda kx_t + \beta E_t \{\pi_{t+1}\}$$

Notice this Phillips expression is in terms of $E_t\{\pi_{t+1}\}$ rather than $E_{t-1}\{\pi_t\}$, hence, inflation depends exclusively on the discounted sequence of future output gaps.
Reconciling the new Phillips curve with the data is difficult. The previous expression suggests that a current change in inflation should depend negatively on the lagged output gap. Lagging the previous expression one period and assuming $\beta = 1$,

$$\pi_t = -\lambda k x_{t-1} + \pi_{t-1} + \varepsilon_t \quad \varepsilon_t = \pi_t - E_{t-1}\pi_t$$

A typical estimate is,

$$\pi_t = 0.081x_{t-1} + \pi_{t-1} + \varepsilon_t$$

The benchmark new Phillips curve implies that inflation should lead the output gap over the cycle – a rise (decline) in current inflation should signal a subsequent rise (decline) in the output gap. However, the opposite is found in the data!
Why does the benchmark Phillips curve fail?

- the output-gap co-moves positively with future inflation, and negatively with lagged inflation, thus explaining the negative coefficient.
- The new PC does not allow for short run trade-offs between output and inflation.
• Hence, a disinflation of any size could be achieved costlessly and immediately by the central bank.

• However, the historical evidence is that disinflations are very costly.

• Extensions of the new Phillips based on empirical considerations consist on specifications such as,

\[ \pi_t = \delta x_t + (1 - \phi)E_t\{\pi_{t+1}\} + \phi \pi_{t-1} \]

so that disinflations now involve costly output reduction. However, these extensions are also not successful empirically.

• **Other Shortcomings:** (1) the output gap is not directly observable.

• (2) movements of the real marginal cost tend to lag movements in output rather than being a coincident movement. Hence, the empirical negative sign.
New Estimates of the New Phillips Curve

Measuring real marginal cost

Cobb-Douglas production:

\[ Y_t = A_t K_t^\alpha_k N_t^\alpha_n \]

Real marginal cost:

\[ MC_t = \frac{W_t}{P_t} \frac{1}{\frac{\partial Y_t}{\partial N_t}} = \frac{S_t}{\alpha_n} \]

where \( S_t \) is the labor income share. In percent deviations from steady state: \( mc_t = s_t \)

Thus, the new Phillips curve can be expressed as

\[ \pi_t = \lambda s_t + \beta E_t \{ \pi_{t+1} \}, \quad \lambda = \frac{(1-\theta)(1-\beta\theta)}{\theta} \]

which can be estimated by GMM using the condition

\[ E_t \{ (\pi_t - \lambda s_t - \beta \pi_{t+1}) z_t \} \]

and thus,

\[ \pi_t = 0.023 s_t + 0.942 E_t \{ \pi_{t+1} \} \]
A New Hybrid Phillips Curve

In addition to Calvo (1983) pricing, assume a fraction $1 - \omega$ of firms is forward looking, but a fraction $\omega$ is backward looking.

Aggregate price evolves according to:

$$p_t = \theta p_{t-1} + (1 - \theta) \bar{p}_t^*$$

with

$$\bar{p}_t^* = (1 - \omega) p_t^f + \omega p_t^b$$

$$p_t^f = (1 - \beta \theta) \sum_{k=0}^{\infty} (\beta \theta)^k E_t \{m c_{t+k}^n \}$$

$$p_t^b = p_{t-1}^* + \pi_{t-1}$$
Remarks

• As long as inflation is stationary, the backward looking optimal price converges to the optimal behavior over time.

• Forward looking behavior enters the backward looking price to the extend that forward looking behavior determines $p_{t-1}^*$

Combing expressions:

$$\pi_t = \lambda mc_t + \gamma_f E_t \{\pi_{t+1}\} + \gamma_b \pi_{t-1}$$

$$\lambda \equiv (1 - \omega)(1 - \theta)(1 - \beta \theta)\phi^{-1}$$

$$\gamma_f \equiv \beta \theta \phi^{-1}$$

$$\gamma_b \equiv \omega \phi^{-1}$$

$$\phi \equiv \theta + \omega[1 - \theta(1 - \beta)]$$
Remarks:

• The forcing variable is real marginal cost instead of the output gap.
• All the coefficients are explicit functions of the model parameters.
• When $\omega = 0$, all firms are forward looking and the model converges to new Phillips curve.
• When $\beta = 1$, $\gamma_f + \gamma_b = 1$ and the model takes the form of the empirical hybrid model.
Results:

• Forward-looking behavior is more important than backward-looking behavior.

• There is a robust and significant impact of marginal costs on inflation in the right direction.

• The weight on lagged inflation is generally small.

• Sluggish behavior of real marginal cost may help account for the sluggish response of inflation to output and thus why disinflations may entail costly output reductions.