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Evidence from the Euro Area

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A "Hybrid" Monetary Policy Model: Evidence from the Euro Area

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Abstract

The New IS and Phillips curves state that output and inflation are purely forward-looking but this theory is conflicting with the empirical results. This note analyses how some augmented version of those curves, called hybrid IS and Phillips curves are more consistent with the data properties.

Keywords: Euro area, habit formation, IS curve, Phillips curve, rule of thumb, monetary policy rule

JEL Classifications: C32, E17

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1 Introduction

Recent years have seen the proliferation of a new generation of small-scale monetary business models called "New Neoclassical Synthesis" models. These new Dynamic Stochastic General Equilibrium (DSGE) models have enjoyed a measure of success in accounting some features of the business cycle fluctuations in quantities and reproducing some evidences on developed countries. However, these models have been notoriously unsuccessful in explaining the data, particularly the high degree of persistence in inflation and output. The major source of these bad estimations comes from the traditional optimizing behavior of the agents which imply the state variables to depend only on their anticipated values. To get round this misspecification, some authors (Gali, Gertler and Lopez-Salido (2001) or Amato and Laubach (2001) among others) have proposed to introduce backward effect in imposing a part of the agents, households and firms, to follow rules-of-thumb in choosing respectively their consumption or prices. Using a hybrid specification for the two curves allows a better fit and capture an empirical important key future of aggregate data, the "hump-shaped" gradual responses of spending and inflation to shocks (Fuhrer (2000)). Instead of taking an *ad-hoc* rule-of-thumb for the households, we propose a totally microfounded hybrid IS curve. Our strategy is to test whether a hybrid model provides a better characterization of the Euro area than a standard new-keynesian one.

The paper is organized as follows. Section 2 presents the model and details more particularly the IS curve derivation. Section 3 proposes some empirical evidences by means of test and simulation. Section 4 concludes.

2   The model

The "hybrid" monetary policy model is a small macroeconomic model designed to describe the behavior of economy-wide variables that enter in most discussions of monetary policy. There are three endogenous variables: the output gap y_t, the inflation π_t and the nominal interest rate i_t. We present in this section the core equations that describe the dynamics of these variables.

2.1   The hybrid IS curve

Instead of using an ad-hoc rule-of-thumb as proposed by Amato and Laubach (2001) to derive the IS curve, we propose a totally microfounded IS equation based on the hypothesis of habit formation. As explained by Carroll (2001), *"the resurgence of interest in habits has been provoked by the emergence of empirical findings that are difficult to explain using the traditional model in which utility is time-separable"*. Here, we specify that habit formation is *external,* as in Abel (1990) "catching up with the Joneses" formulation and that the habit stock H_t equals the level of aggregate consumption in the previous period $\bar{C}_{t-1}$ $\left(H_t = \bar{C}_{t-1} \right)$.

On this basis, the specification of the demand side is on the spirit of the one used by Neiss and Nelson (2001). There is a large number of households who have preferences defined over a composite consumption good (C_t) *à la* Dixit-Stiglitz, labor (N_t), and real money balances (M_t/P_t). They differ in that they supply a differentiated type of labor. Money enters the utility function directly to capture the idea that real balances provide a transactions-facilitating service.

The representative household chooses a sequence of consumption (C_t), labor (N_t), nominal money (M_t), and one-period bond (B_{t+1}), to maximize his lifetime utility:

$$E_t \sum_{\tau=0}^{\infty} \beta^{\tau} \varepsilon_t^p \left\{ u\left(C_{t+\tau}, H_{t+\tau}\right) - l\left(N_{t+\tau}\right) + v\left(\frac{M_{t+\tau}}{P_{t+\tau}}\right) \right\} \tag{1}$$

where $\beta \in [0,1]$, $u\left(C_{t+\tau}, H_{t+\tau}\right)$, $l\left(N_{t+\tau}\right)$, $v\left(\frac{M_{t+\tau}}{P_{t+\tau}}\right)$, and ε_t^p represent respectively the discount factor, the instantaneous consumption utility, the instantaneous work desutility, the utility associated to the real cash balances and a general shock to preferences. Because we only need the Euler equation to derive the IS curve, we just give the consumption utility form (the specification of $l\left(.\right)$ and $v\left(.\right)$ has no importance here):

$$u\left(C_t, H_t\right) = \frac{\sigma_c}{\sigma_c - 1} \left(C_t - hH_t\right)^{\frac{\sigma_c - 1}{\sigma_c}}, \tag{2}$$

where σ_c is the intertemporal elasticity of substitution of consumption, h represents the habit formation parameter which measures the effect of habit stock and current utility $(0 \leq h \leq 1)$. Households respect at each period the intertemporal budget constraint:

$$C_t + \frac{M_t}{P_t} + \frac{B_{t+1}}{P_t} \leq HTI_t + (1 + i_{t-1}) \frac{B_t}{P_t} + \frac{M_{t-1}}{P_t} - \frac{T_t}{P_t} \tag{3}$$

where T_t denotes government transfers and (HTI) is the household's total income which generally consists of three components: labor income, the return in capital stock minus the adjustment costs of investment and the dividends derived from the imperfect competitive intermediate firms.[1]

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[1]But to simplify our presentation, we does not formalize here the capital accumulation. See

Preferences over consumption take on a non time separable form to capture the idea that households may exhibit habit formation in their consumption patterns.

Letting μ_t the Lagrange multiplier on (3), π_t the inflation rate defined as P_{t+1}/P_t, and from the first order conditions, the household's optimal choice must satisfy:

$$\mu_t = \varepsilon_t^p \left(C_t - hH_t \right)^{-\frac{1}{\sigma_c}} \tag{4}$$

$$E_t \left(\frac{1 + i_t}{1 + \pi_{t+1}} \right) = \left[E_t \left(\beta \frac{\mu_{t+1}}{\mu_t} \right) \right]^{-1} \tag{5}$$

Equations (4) and (5) extend the usual first-order condition for consumption growth by taking into account the existence of external habit consumption.

In linearizing equation (5) with equation (2), we find in neglecting the government spending, a consumption equation with external habit equation:[2]

$$\hat{c}_t = \frac{h}{1+h}\hat{c}_{t-1} + \frac{1}{1+h}E_t\hat{c}_{t+1} - \frac{(1-h)\,\sigma_c}{(1+h)}\left(i_t - E_t\pi_{t+1} - r^* \right) + \frac{(1-h)\,\sigma_c}{(1+h)}\left(\hat{\varepsilon}_t^p - \hat{\varepsilon}_{t+1}^p \right)$$

$$\tag{6}$$

with $r^* = -\ln\beta$.

When $h = 0$, this equation reduces to the traditional forward-looking consumption equation. With external habit formation, consumption depends on a weighted average of past and expected future consumption. Note that in this case the interest elasticity

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Casares and McCallum (2000) for a well detailed specification of the adjustement costs of investment function.

[2] We note $x_t = \ln X_t$ and $\hat{x}_t = \left(X_t - \bar{X} \right)/\bar{X} \simeq \ln X_t - \ln \bar{X}$, the relative gap between the variable X_t and its stationnary value $\bar{X}$.

of consumption depends not only on the intertemporal elasticity of substitution, but also on the habit persistence parameter. A high degree of persistence will tend to reduce the impact of the real rate on consumption for a given elasticity of substitution.

Because the global demand for goods is the sum of private consumption and public spending (g_t): $\hat{y}_t = j_1 \hat{c}_t + j_2 \hat{g}_t$, if we combine the last two equations, the demand for goods is:[3]

$$\hat{y}_t = \frac{h}{1+h}\hat{y}_{t-1} + \frac{1}{1+h}E_t\hat{y}_{t+1} - \frac{j_1(1-h)\sigma_c}{(1+h)}(\hat{i}_t - E_t\hat{\pi}_{t+1}) + \varepsilon_{y,t} \qquad (7)$$

Finally, in noting $\alpha_y \equiv (1+h)^{-1}$ and $\alpha_r \equiv -\dfrac{j_1(1-h)\sigma_c}{(1+h)}$, we obtain the hybrid IS curve:

$$\hat{y}_t = (1-\alpha_y)\hat{y}_{t-1} + \alpha_y E_t\hat{y}_{t+1} + \alpha_r(\hat{i}_t - E_t\hat{\pi}_{t+1}) + \varepsilon_{y,t} \qquad (\text{IS})$$

2.2   The hybrid Phillips curve

Gali, Gertler and Lopez-Salido (GGL, 2001) have developed a hybrid version of the New Keynesian Phillips (see this paper for the details of its derivation), so we choose a close version given by

$$\hat{\pi}_t = (1-\beta_\pi)\hat{\pi}_{t-1} + \beta_\pi E_t\hat{\pi}_{t+1} + \beta_y\hat{y}_t + \varepsilon_{\pi,t} \qquad (\text{Phillips})$$

where $0 < \beta_\pi < 1$ determines the degree to which imperfectly competitive firms are forward-looking when setting their prices and β_y is related to the degree of price stick-

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[3] $\varepsilon_{y,t}$ is a composite shock defined by $\varepsilon_{y,t} \equiv j_2\hat{g}_t - \frac{h}{1+h}j_2\hat{g}_{t-1} - \frac{j_2}{1+h}E_t\hat{g}_{t+1} + \frac{j_1(1-h)\sigma_c}{(1+h)}\left(\hat{\varepsilon}_t^p - \hat{\varepsilon}_{t+1}^p\right)$

iness (more stickiness implies a lower value of β_y). To derive this reduced-form, we assume, as in the baseline Calvo model, that at each period only fraction of suppliers is offered the opportunity to choose a new price, while the remaining suppliers have to maintain whichever price they charged before. The underlying idea is that among the firms that are able to change their price, we can distinguish between firms that are forward-looking (a fraction β_π) and those that are backward-looking (a fraction $(1 - \beta_\pi)$) and use a simple rule of thumb. $\varepsilon_{\pi,t}$ is a cost-push shock. We insist on the fact that in our formulation, we impose the sum of the coefficient between the forward and backward terms to be equal the unity. It is worth emphasizing that this assumption is not restrictive since the sum of the weights in the GGL model should be very close to one.[4]

2.3   The monetary policy rule

We close the model by adding a monetary policy rule in which the short nominal interest rate is the monetary authorities privileged instrument. A standard instrument rule is given by $i_t = f(X_t)$ where $f(X_t)$ represents a reaction function explicit or implicit in which $X_t = (y_t, \pi_t, i_t)$ is a vector of state variables (lagged, present or anticipated). This traditionnal rule cannot capture the tendency of central banks to smooth changes in interest rates.[5] We simply assume that the actual rate partially adjusts to the target and so this partial adjustment form links the instrument to its own lag value, anticipated inflation (to justify the existence of possible monetary

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[4]Furthermore, it appeared in our preliminary regressions that free estimation of the weight parameters almost satisfied this constraint.

[5]The explanations may be the fear of disrupting financial markets, loss of credibility from sudden large policy reversals or the presence of large uncertainty in the economy.

policy transmission delays to the economy) and output gap, plus an error $\varepsilon_{i,t}$:[6]

$$\hat{\imath}_t = \psi_i \hat{\imath}_{t-1} + (1 - \psi_i) \left[\psi_\pi E_t \hat{\pi}_{t+1} + \psi_y \hat{y}_t \right] + \varepsilon_{i,t} \qquad \text{(Rule)}$$

3   Empirical evidences

Current output-gap and inflation depend on expected future output-gap and inflation, so we need an expectation for y_{t+1} and π_{t+1}. A relatively straightforward econometric procedure is the Generalized Method of Moment (GMM), in which expectational errors $\pi_{t+1} - E_t \pi_{t+1}$ and $y_{t+1} - E_t y_{t+1}$ are assumed to be uncorrelated with all variables in the information set of agents available at date t. Under rational expectations, the GMM exploits the orthogonality conditions between the expectational error and the whole information set of agents which can be composed by inflation, output-gap and interest rate.

Firstly, we use the GMM approach to replicate the present value test.

Secondly, because this approach seems to be problematic in estimating such type of equations or models[7] - (i) the GMM estimators are biased in small sample and (ii) we can obtain the result that forward-looking behavior matters even when it does not in the DGP -, we choose to apply the well-known *model-consistent* approach of Full Information Maximum Likelihood to estimate our model and do some simulations.

We use annual data on Euro area over the period 1974-2000 taken in the OECD

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[6] This error can be view as an assessment error on the market inflation expectations done by the monetary authorities

[7] see for example Florens, Jondeau and Le Bihan (2001) who have investigated the robustness of GMM estimates of a forward-looking Taylor rule.

data base. The output gap is measured as the percentage deviation of a linear trend, the inflation rate is the annual percentage change in GDP deflator and the nominal short-term interest rate is the quarterly average rate during a year.

3.1   The present-value test

We follow the present-value test presented by Rudd and Whelan (2001) to analyze the IS and Phillips curves properties. This test says that if the new-keynesian interpretation of the reduced-forms for IS and Phillips curves are correct, then the inclusion of the present-value term should result in a substantial reduction in the coefficients on lagged values of the driving-variables relative to those obtained from the purely backward-looking specifications.

These authors show that we can construct simple proxy for the infinite discounted sum of the expected future values of the driving variables and so rewrite the "closed-form" solutions for output gap and inflation as:

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\begin{aligned}
y_t &= A\left(L\right)y_{t-1} + \alpha_r \sum_{i=0}^{K} E_t\left(i_{t+i} - \pi_{t+i+1}\right) + E_t\left(y_{t+K+1} - A\left(L\right)y_{t+K}\right) \\
\pi_t &= B\left(L\right)\pi_{t-1} + \beta_y \sum_{i=0}^{K} \beta^i E_t y_{t+i} + E_t \beta^{K+1}\left(\pi_{t+K+1} - B\left(L\right)\pi_{t+K}\right)
\end{aligned}
$$

The results given in table 1 (with $K = 4$ and $\beta = 0.95$) provide little support for the view that forward-looking behavior is an important determinant of output gap and inflation dynamics.[8] For the IS curve, we see that α_r (the coefficient on the

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[8] We use two lags of each instrument because it seems to correctly capture the economy dynamics (the main motivation for this choice comes from VAR literature).

present-value term) does not receive the correct sign in the model that excludes any lags of inflation. When the lagged output gap term $A_1 y_{t-1}$ is introduced, we obtain further evidence that the forward-looking behavior posited by the new-keynesian IS curve is of limited empirical importance: α_r receives the correct sign (negative) in theses specifications, the sum of the coefficients on lagged output gap is about 0.98. But in both cases, these estimates are virtually identical to the coefficients on lagged output gap from the autoregressions. For the Phillips curve, we see that β_y receives the correct sign in all the model specifications. But now again the estimates of the coefficient on lagged inflation ($B_1 \pi_{t-1}$) are virtually identical to the coefficients on lagged output gap from the autoregressions (0.98). Thus, we find essentially no evidence that the role assigned to lags of output gap (resp. lags of inflation) in reduced-form IS curve (resp. reduced-form Phillips curve), comes from their proxying for expected future real interest (resp. output-gap), as the new-keynesian model suggests.

3.2   Estimates and simulation

Table 2 presents the new-keynesian model parameters estimates and those of the hybrid monetary policy model. As shown by the present value test, the results imply that the backward elements have a real importance. Conversely to the new-keynesian model estimated parameters, those of the hybrid model have the expected sign and are significant. We observe that the weight on the forward-looking variables is a bit more than one half (0.51) for $E_t y_{t+1}$ and a bit less than one half (0.46) for $E_t \pi_{t+1}$, showing the low forward-looking behavior of the agents. Schematically, these results

capture the great importance of households habit ($h = 0.96$) and the fact that near one half of the firms are backward-looking when modify their prices.

We use the estimated parameters to do simulations and to get a feeling for the typical dynamics in the economy. We observe that the new keynesian model is unsuccessful in explaining the stylized facts, in particular the response to shocks like a demand shock or a monetary policy shock. For example, Figure 1 shows that after a 1 percentage point demand shock $\varepsilon_{y,t}$, output gap increases immediately and take few periods to return to its steady state. This result comes from the fact that the specification is purely forward-looking and so the households and firms expect perfectly the long run: dynamics in this economy is relatively poor. Conversely, in the hybrid monetary policy model, the impulse responses (Figure 2) indicate a lot of persistence in the economy in response to the third shocks. All shocks display the hump-shaped pattern seen in estimated stationary VAR(2) for the Euro area.[9]

4   Conclusion

This note shows empirically that with some hybrid equations for output and inflation, not necessarily *ad-hoc* but with some microfoundations, we can build a simple monetary policy model replicating quite well the stylized facts on the dynamics of the economy. Further research could investigate the introduction of some more specific Euro-area features as heterogeneities or analyzis this simple model in an two-countries economy.

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[9]Given uncertainty about the order of integration of the data, we choose a stationary representation of the data.

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Table 1. Closed-form equations

Specifications	IS curve		Phillips curve	
	α_r	A_1	β_y	B_1
Present-value	0.201 (0.081)		0.258 (0.190)	
Lags +Present-value	−0.173 (0.044)	0.976 (0.225)	0.076 (0.066)	0.972 (0.154)
Own lags only		0.984 (0.077)		0.988 (0.024)

Note: Standard errors are in parentheses.

Table 2. FIML estimates

Specifications	Parameters						
	α_y	α_r	β_π	β_y	ψ_i	ψ_π	ψ_y
New Keynesian model	-	−0.06 (0.04)	0.98 (0.07)	−0.10 (0.34)	0.76 (0.08)	1.22 (0.18)	1.99 (1.55)
Hybrid monetary policy model	0.51 (0.16)	−0.06 (0.03)	0.46 (0.08)	0.06 (0.03)	0.88 (0.11)	1.73 (0.29)	2.61 (0.87)

Note: Standard errors are in parentheses.
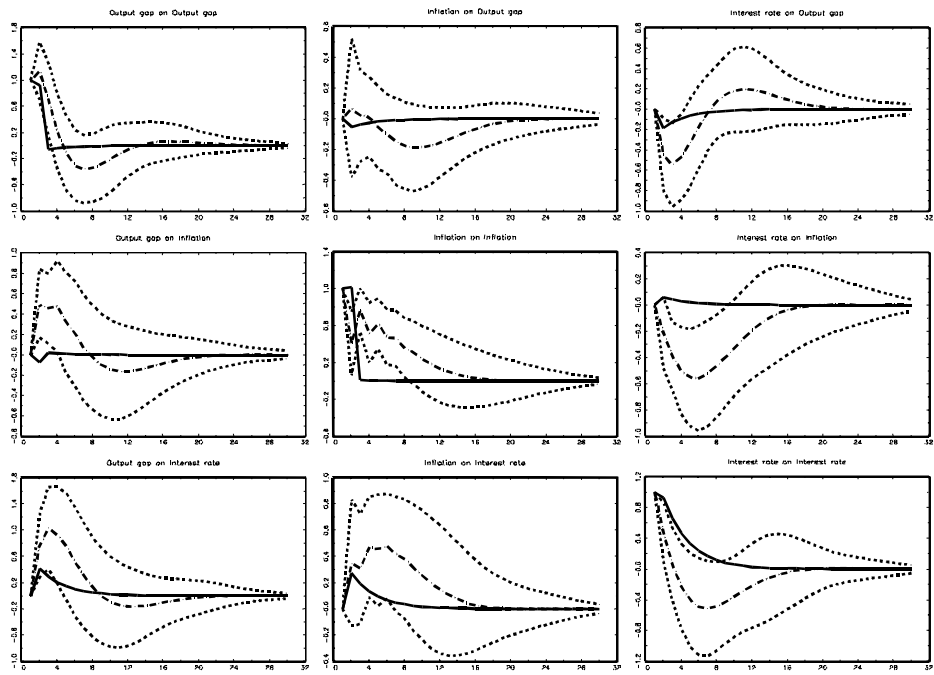
Figure 1. Impulse responses of VAR vs. New Keynesian model
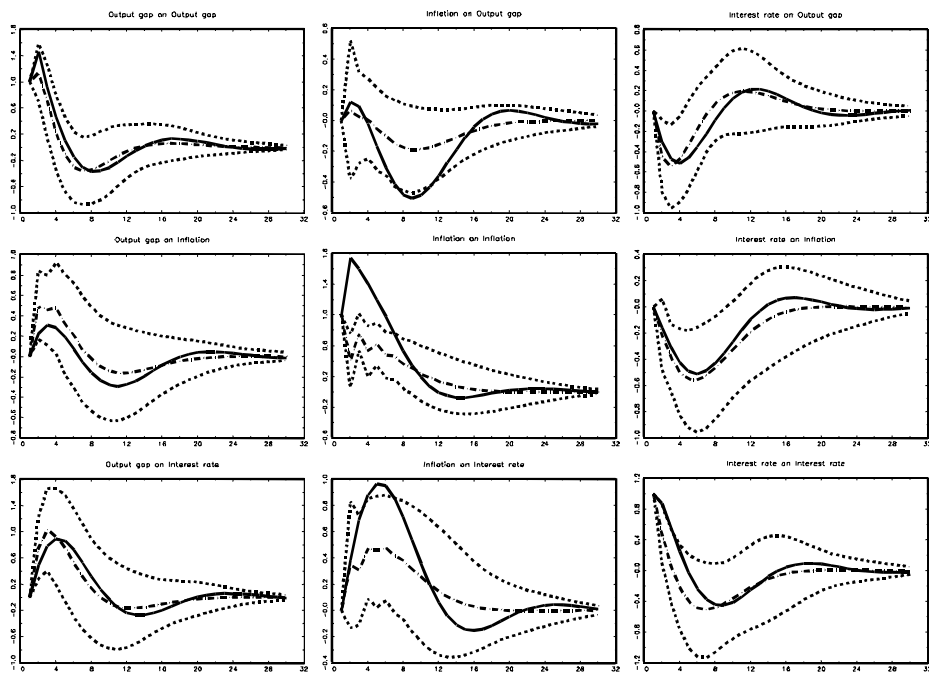
Figure 2. Impulse responses of VAR vs. Hybrid monetary policy model

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