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On money and output in the euro area: Is money redundant?

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The relationship between money and output in the euro area is tested in the context of a two-equation model. An interesting aspect of the empirical analysis is the evidence that the real M3 has a correctly signed and statistically significant impact on business cycle fluctuations, given the real interest rate and foreign output. This finding supports the argument made by proponents of monetarism that the effects of monetary policy actions on the real economy are not fully captured by the short-term real interest rate.

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1. Introduction

During the last decade, it has been a tendency in monetary policy analysis to be conducted in models where money plays no explicit role. The research conducted by both central banks and academic economists has used small-scale dynamic stochastic general equilibrium (DSGE) models which include a forward-looking IS equation, a forward-looking Phillips curve and a Taylor policy rule. This type of models limits the influence of monetary policy on real output to its effect through the short-term real interest rate. MacCallum (2001), for example, calibrating a DSGE model where money has a transaction role, finds that neglecting liquidity premia is appropriate. The emerging consensus that money can be largely ignored in making monetary policy decisions has been protested by proponents of monetarism. Meltzer (2001) argues that the short-term real interest rate fails to capture fully the real effects of monetary policy since monetary actions work through by changing relative prices and thus movements in monetary aggregates have a separate effect on aggregate demand, even at near-zero short-term interest rates. Indeed, Meltzer presents evidence that the growth rate of the real money base affects positively and significantly the growth rate of US real consumption after controlling for the real interest rate. Nelson (2002) presents additional evidence that the same property of real base money holds for total output. Hafer, Haslag and Jones

(2007) show that money has information content, beyond the information content of the real interest rate that helps predict the output gap in US.

Even though, the role of money in shaping business cycle fluctuations in US has been well documented in the empirical literature, in the euro area, on the other hand, the analysis of the real effects of money has produced mixed results.¹ Andrés, Lopez-Salido and Vallés (2006), using a DSGE that elaborates on the seminal work by Ireland (2004), find that the business cycle influence of money balances is very limited, thus preferences are separable between consumption and real money. Barthelemy, Clerk and Marx (2008), using a similar model which allows for an asymmetric response of European Central Bank (ECB) to monetary developments, find that money plays a significant role in propagating cyclical fluctuations and recommend that the ECB should factor in monetary developments in its monetary policy decisions. However, the parameter estimates measuring the importance of real money balances in the IS equation has a negative sign, associating an increase in real money balances with a decline in real output. Canova and Menz (2009), using a different specification of the DSGE model that allows for habit in consumption and posits a policy rule where the nominal growth rate of money matters, show that the role of money in transmitting fluctuations to output is quite small.

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¹ In the euro area money plays a prominent role in the conduct of monetary policy with respect to the medium-term price level developments, as signaled by the announcement of a quantitative reference value of 4,5% for the rate of growth of the broad monetary aggregate M3. The role of money in achieving price stability has been well documented in the empirical literature (see Gerlach and Svensson, 2003).

Since the analysis of the real effects of money in the euro area in the context of a forward-looking IS curve has produced mixed results, which, at best, indicate a negative impact of real money on real output and, at worst, the rejection of any major impact at all, this study aims at providing new evidence of the role of money in propagating business cycle fluctuations in the euro area using a backward-looking version of the IS curve, of the type popularized by Rudebusch and Svensson (1999) and applied successfully to US data by Nelson (2002) and Hafer, Haslag and Jones (2007). Contrary to that literature examining the monetary aspects of business cycle fluctuations in the context of a single equation, I study the question of interest using a small-scale macro-model estimated with simultaneous equations methods.

2. The theoretical background

In this section, I set out a small-scale macro-model which consists of an aggregate demand equation, a traditional Phillips curve and a Taylor policy rule,

$$y_t = ay_{t-1} - br_{t-1} + c'x_{t-j} + v_t^y \quad (1)$$

$$\pi_t = \gamma_0 + \pi_{t-1} + \gamma_1 y_t + v_t^\pi \quad (2)$$

$$i_t = \rho_0 + (1 - \rho_1)(\pi_t + \delta y_t) + \rho_1 i_{t-1} + v_t^i \quad (3)$$

where y_t the output gap, π_t the inflation rate, i_t the short-term nominal interest rate, r_t the ex-post short-term real interest rate, $x_t' = (m_t, y_t^*)$ a vector

containing real money and foreign output gap, and v_t^y , v_t^π and v_t^i are respectively, demand, supply and policy shocks.

The IS curve is that of Rudebusch and Svensson (1999). The backward-looking version is justified by the presence of habit persistence in consumer behaviour, of the type suggested by Fuhrer (2000). Nelson (2002) shows that real money is important in explaining output, once portfolio adjustment costs are present. Since real money is a summary statistic for long-term interest rates which affect the IS and LM equations, it contains information for future real output, not present in the short-term interest rate. Thus, equation (1) is extended to include the growth rate of real money. In addition, the equation includes foreign shocks which are transmitted to the domestic economy mainly through the foreign output.² The Phillips curve equation assumes that lagged inflation, which approximates expected inflation, and output gap determine current inflation. The monetary policy rule sets the nominal interest rate in stabilizing inflation developments and departures of output from trend.

Combining equations (2) and (3), I derive a real interest rate equation,

$$r_t = \phi_0 + \phi_1 r_{t-1} + \phi_2 y_t + v_t^r \quad (4)$$

where $\phi_0 = \rho_0 - \rho_1 \gamma_0$, $\phi_1 = \rho_1$, $\phi_2 = (1 - \rho_1)\delta - \rho_1 \gamma_1$, and $u = v_3 - \rho_1 v_2$. Then, I substitute equation (1) into equation (4) and obtain a vector autoregressive (VAR) system of the form,

$$z_t = A + Bz_{t-1} + \Gamma x_{t-j} + w_t \quad (5)$$

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² The real effective exchange rate it is omitted from the IS equation, since it was not statistically important.

where $z_t' = (y_t, r_t)$, A is a 2×1 vector of constant terms, B is a 2×2 matrix of coefficients of lagged endogenous variables, Γ is a 2×2 vector of coefficients of exogenous variables and w is a 2×1 vector of white noise error terms with covariance matrix Σ_w . Estimation of this system suggests that the null hypothesis of no Granger causality from real money to output gap, given the real interest rate and the foreign output gap, is presented by the joint restriction $\gamma_{1m} = \gamma_{2m} = 0$, where γ_{1m} and γ_{2m} are, respectively, the first elements of matrix Γ , i.e., the coefficients of m_{t-j} in equations y_t and r_t .

3. The data

I test the relationship between real money and business cycle fluctuations in the euro area using a data set which starts at 1999Q1 and terminates at 2008Q1, just before the collapse of real GDP as a result of the global financial crisis. The real GDP in the euro area has been steadily increased up to 2008Q1 (see Figs.1), and then, as a result of the global financial crisis, it has been gradually declined. Up to the second quarter of 2009, the cumulative percentage fall in real output is about 5.4%. To live aside the effects of the financial crisis on aggregate fluctuations, I terminate the sample at the first quarter of 2008.

The aggregate fluctuations are measured by the output gap, y_t , which is computed applying the Hodrick-Prescott filter with a smoothing parameter of

1600 to the log of real GDP.³ Following Rudebusch and Svensson (1999), I construct the monetary measures as lagged moving averages. The real money is defined as the difference between the four-quarter moving average of quarterly growth rates of nominal M3 and the four-quarter moving average of quarterly growth rates of inflation, $m_t = 1/4 \left(\sum_{k=0}^3 (m_{t-k} - \pi_{t-k}) \right)$ and the short-term real interest rate is defined as the difference between the four-quarter moving average of 3-month Libor interest rate of euro and the annualised average of quarterly growth rates of inflation, $r_t = 1/4 \left(\sum_{j=0}^3 (i_{t-k} - \pi_{t-k}^a) \right)$. The foreign output gap is replaced by the US output gap which is computed by applying the Hodrick-Prescott filter to the log of US real GDP.⁴

Figures 2 and 3 plot the bivariate relationship between money and the output gap. The figures show that the relationship between the two variables appears to be close enough. To get a clearer view of the role of money in propagating the business cycle fluctuations in the euro area, I will turn to the estimation of the empirical model.

[insert Figures 1-3]

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³ I estimate a second-order autoregressive equation for the output gap from 1999Q1 to 2010Q2 and test for a significant structural break in an unknown point, using the Quandt LR test, under the hypothesis that the output gap is stationary. The results indicate that the output gap exhibits a significant structural break in 2008Q2.

⁴ The real GDP of euro area and US are obtained from OECD, the money supply M3 and Harmonised consumer price index are obtained from ECB and the 3-month Libor interest rate is obtained from IMF.

4. The empirical results

Firstly, I test for the presence of unit roots using the efficient ADF-GLS test (Eliot, Rothenberg and Stock, 1996) that has a maximum power against very persistent alternatives. The test with two lags yields the following p -values: 0.10 for y_t , 0.02 for m_t , 0.00 for r_t and 0.02 for y_t^* . Therefore, with the exception of the output gap which is a borderline case, the other series can be characterized as stationary processes.

Table 1 reports the results of the VAR system using seemingly unrelated regression estimation (SURE). The real interest rate is statistically significant with a negative sign in the output equation, as implied by the theory, revealing that this type of monetary measure represents an effective mechanism of monetary policy. The joint restriction that the history of real money does not Granger cause the output gap and real interest rate is rejected with a marginal significance level less than 1%, indicating that real money is important to understanding future movements in the output gap, given the history of output gap, real interest rate and US output gap. This finding suggests that there is a direct effect of the real M3 on the output gap independent of the effects of the real interest rate. Given that the lagged real interest rate affects the output gap and the lagged real money affects the real interest rate, there is also an indirect effect of real M3 on the output gap, operating through the real interest rate. In addition, the joint restriction that the history of US output gap does not Granger cause the domestic output gap and the real interest rate is rejected with a marginal significance level less than 1%, indicating that US business cycle

fluctuations are important to understanding future movements in the output gap, given the history of the output gap, real interest rate and real money.

The p -value of F statistic for the restriction that the coefficient of the lagged dependent variable in the output equation equals one is 57%, implying that the SURE estimation imposes a unit root upon the system. Almost identical parameters estimates are obtained, after imposing the homogeneity restriction.

The diagnostic tests indicate that the two-equation model is well-specified. In particular, the portmanteau test does not reject the hypothesis that the error structure of each equation is not serially correlated and the Doornik-Hansen test does not reject the hypothesis of multivariate normality of the error structure. In the context of a backward-looking model, the Lucas Critique may apply with particular force, so it is important to gauge the historical importance of the IS curve with stability tests. The Quandt LR test reveals that instability in the parameter estimates does not exist, something which is confirmed by the CUSUM squares test (Fig. 4).

Table 2 reports the results for the recursive system of equations (1) and (4), using limited information maximum likelihood (LIML). The parameters estimates of the output equation are the same as before, revealing that, statistically speaking, real money matters for aggregate fluctuations, given real interest rate and foreign output. In the real interest rate equation, the output gap has a statistically significant positive impact, reflecting the stabilizing feature

of the policy mechanism to aggregate fluctuations.⁵ The sum of the coefficients of the lagged dependent variable equals 0.79, which is statistically different from one with a marginal significance level less than 1%, indicating an interest rate smoothing. For instrumental methods to be informative, a significant amount of predictability for the real interest rate is needed which it turns out to mean that the parameters estimates are not significantly changing with changes to the instrument set. One way of assessing the severity of weak instruments is to calculate the F -statistic from the first stage regression of the output gap against a set of instruments. If this F -statistic is too low, then it is said that we are using weak instruments. The rule of thumb is that a value bigger of 10 indicates no weak instruments in the case of one endogenous regressor (Stock, Wright and Yogo, 2002). The output gap equation provides the required instruments for the estimation of the real interest rate equation. The first-stage F -statistic for instrument relevance is equal to 17.89, showing that the weak identification problem is not present in the real interest rate equation.⁶

The diagnostic tests indicate that the recursive model is well-specified. In particular, the portmanteau test does not reject the hypothesis that the error structure of each equation is not serially correlated and the Doornik-Hansen test does not reject the hypothesis of multivariate normality of the error structure.

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⁵ The real interest rate equation includes the second lag of the dependent variable because it improves the fit.

⁶ For a detailed discussion of weak instruments and their effects, see Dufour and Jasiak (2001), Dufour (2003) and Andrews and Stock (2006).

5. Concluding remarks

In this paper, I present empirical evidence about the real effects of the monetary measure M3, which is used in the “two-pillar” monetary policy strategy of the ECB. An interesting aspect of the empirical analysis is the evidence that the real money has a correctly signed and statistically significant impact on business cycle fluctuations, indicating that its path is important to understanding future movements in the output gap, given the real interest rate and foreign output. This finding is consistent with the evidence obtained by other studies using US data and a comparable IS equation. The present analysis provides a negative answer to the question posed in the title of the paper, supporting further the argument made by Meltzer that the effects of monetary policy actions on the real economy are not fully captured by the short-term real interest rate. Therefore, the ECB should factor in monetary developments in its monetary policy decisions.

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Table 1. Seemingly unrelated regression estimation

<u>Output equation</u>			<u>Real interest rate equation</u>		
<i>Regressors</i>	<i>Coeff.</i>	<i>p-value</i>	<i>Regressors</i>	<i>Coeff.</i>	<i>p-value</i>
y_{t-1}	0.96	0.00***	r_{t-1}	1.19	0.00***
r_{t-1}	-0.09	0.03**	r_{t-2}	-0.45	0.00***
m_{t-2}	0.17	0.03**	y_{t-1}	0.29	0.00***
y_{t-1}^{us}	0.19	0.00***	m_{t-2}	0.14	0.00***
			y_{t-1}^{us}	0.06	0.08*

Summary statistics and diagnostics

System:

Dornick-Hansen normality test: $\chi^2(4) = 2.47[0.65]$

Hansen-Sargan over-identification test: $\chi^2(2) = 2.33[0.31]$

Quandt LR test: $F(5,22) = 2.36[10\% \text{ } p\text{-value} = 3.26]$

Output equation: $SEE=0.0017$, *Q test:* $\chi^2(8) = 4.87[0.77]$

Residuals unit root test: $ADF(1)\text{-}GLS = -3.76[0.00]^{***}$

Interest rate equation: *adjusted* $R^2=0.99$, $SEE=0.10$, *Q test:* $\chi^2(8) = 12.54[0.13]$, *Residuals unit root test:* $ADF(3)\text{-}GLS = -3.99[0.00]^{***}$

Tested restrictions

$\gamma_{1m} = \gamma_{2m} = 0$ $F(2,52) = 6.80[0.00]^{***}$

$\gamma_{1y^{us}} = \gamma_{2y^{us}} = 0$ $F(2,52) = 9.09[0.00]^{***}$

Homogeneity restriction (equation y_t): $F(1,52) = 0.32[0.58]$

The interest rate equation also includes a significant constant term.

*** (**) = $p\text{-value} \leq 1\%$ (5%).

Table 2. Limited information maximum likelihood estimation

<u>Output equation</u>				
<i>Regressors</i>	<i>Unconstrained LIML</i>		<i>Constrained LIML</i>	
	<i>Coeff.</i>	<i>p-value</i>	<i>Coeff.</i>	<i>p-value</i>
y_{t-1}	0.96	0.00***	1.00	
r_{t-1}	-0.09	0.03**	-0.11	0.00***
m_{t-2}	0.17	0.03**	0.19	0.00**
y_{t-1}^{us}	0.19	0.00***	0.18	0.00***

Real interest rate equation

<i>Regressors</i>	<i>Coeff.</i>	<i>p-value</i>
const	0.64	0.00***
r_{t-1}	1.12	0.00***
r_{t-2}	-0.37	0.00***
y_t	0.35	0.00***

Summary statistics and diagnostics

System:

Dornick-Hansen normality test $\chi^2(4) = 4.55[0.34]$

cross-correlation of errors = -0.31, $t(29) = -1.77[0.08]$ *

Output equation:

SEE=0.018, *Q test* $\chi^2(8) = 4.8[0.77]$

Over-identification $\chi^2(2) = 2.42[0.30]$

Residuals unit root test: ADF(1)-GLS=-3.73[0.00]***

Interest rate equation:

SEE=0.12, *Q test*: $\chi^2(8) = 7.62[0.47]$

Over-identification $\chi^2(2) = 3.45[0.18]$

Residuals unit root test: ADF(1)-GLS=-3.40[0.00]***

Weak instrument test: F(3,25)=17.89

Tested restriction:

Homogeneity restriction (output equation): F(1,54)=0.28[0.60]

*** (**) = p -value $\leq$ 1% (5%).

Figure 1. Euro area real GDP (in logs)

Figure 2. Output gap and growth rate of M3

Figure 3. Change in output gap and growth rate of M3

Figure 4. CUSUMSQ plot with 95% confidence band