Monetary Policy Shocks in the Euro Area and Global Liquidity Spillovers

by

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Abstract

This paper analyses the international transmission of monetary shocks with a special focus on the effects of foreign money ("global liquidity") on the euro area. We estimate structural VAR models for the euro area and the global economy including a global liquidity aggregate. The impulse responses obtained show that a positive shock to extra-euro area liquidity leads to permanent increases in the euro area M3 aggregate and the price level, a temporary rise in real output and a temporary appreciation of the real effective exchange rate of the euro. Moreover, we find that innovations in global liquidity play an important role in explaining price and output fluctuations in the euro area and in the global economy.

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Keywords: Monetary policy, Structural VAR, International spillovers.

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1 Introduction

Recently, there has been an increasing interest in the sources of international business fluctuations on the one hand, and in the role played by international spillovers of monetary policy shocks on the other hand. Mounting evidence suggest that the cross-country transmission of shocks plays an important role in international business fluctuations, but so far only a limited number of studies have examined the role of shocks to monetary aggregates in driving business fluctuations or, more generally, in influencing the behaviour of macroeconomic and financial variables in other countries (Kim and Roubini; 2000, Kim; 2001, Holman and Neumann; 2002). The weak performance of money demand models in many countries in terms of stability and the generally low explanatory power of monetary models of exchange rate determination partly explain this circumstance. This contrasts with a recent research strand, which focuses on the usefulness of money as an indicator of macroeconomic developments in closed-economy models (Trecroci and Vega; 2000, Amato and Swansson; 2001, Dotsey and Hornstein; 2003). This paper provides an attempt to fill this gap by studying the international transmission of monetary shocks with a special focus on the effects of foreign money ("global liquidity") on the euro area economy.

There are several reasons why monetary developments abroad should be taken into account by an open economy. Given the high level of integration attained in financial markets, cross-country capital flows may have non-negligible effects on domestic asset prices or monetary aggregates. In a first channel of transmission (the "push" channel), high monetary growth in one area may lead to capital flows into foreign countries, thus resulting in stronger monetary growth and higher asset returns abroad; while according to the "pull" channel, high domestic monetary growth may lead to domestic asset price inflation and, as a result, attract foreign capital, thereby depressing asset prices in the countries where the capital flows originated (Baks and Kramer; 1999). These effects operate not only at times of stress in financial markets (as witnessed for instance by the quick spreading of the Asian crisis in many countries of the South-East Asia and other emerging markets economies in 1997), but also in "normal times".

Furthermore, in the absence of capital flows between regions, the very existence of common international exogenous shocks may lead to co-movements of monetary aggregates in different countries. From a single country perspective, such co-movements can be exploited to reveal information about the sources of the shocks hitting the domestic economy. For instance, shocks associated to international stock price volatility may lead to increases in both domestic and foreign monetary aggregates due to a worldwide increased preference for liquid assets. In this case information on foreign developments may help to confirm that such liquidity preference shock was the likely cause of the observed fluctuation in domestic monetary aggregates.

The aim of this paper is to study the role of monetary aggregates in an international context. We choose to do so within the context of structural vector autoregressions (SVARs). We first propose two models that are taken as a benchmark for the euro area economy using only domestic variables (i.e. prices, output, the short-term interest rates and the exchange rate). From these models it is possible to identify the "true" exogenous monetary policy shocks over the period 1980-2001. Then, following a marginal approach (Kim; 2001), we add to the block of endogenous variables a global liquidity aggregate (i.e. an aggregation of broad monetary aggregates of major economies expressed in the same currency) and analyse how euro area variables respond to shocks to foreign money. Finally, we propose an aggregate SVAR model for the G5 economies (US, euro area, Japan, UK and Canada) in order to investigate whether global liquidity has information content for the global macroeconomic development.

The paper is organised as follows: Section 2 provides some information on stylised facts about global liquidity, Section 3 presents the empirical framework of the SVAR analysis, Section 4 proposes the two benchmark models for the euro area. In Section 5 the study of the euro area monetary policy is enlarged to include a foreign variable (global liquidity), while in Section 6 we deal with a SVAR model with aggregate variables for the group of the G5 countries. Section 7 concludes.

2 Preliminary evidence on global liquidity

The global liquidity aggregate analysed in this paper is constructed as a sum of the monetary aggregates of the US, the euro area, Japan, the UK and Canada, using exchange rates vis-à-vis the euro based on purchasing power parities to convert them into a common currency (see data annex for further details).

Figure 1 plots the annual growth rate of the aggregation of non-euro area monetary aggregates previously converted into euro at the PPP exchange

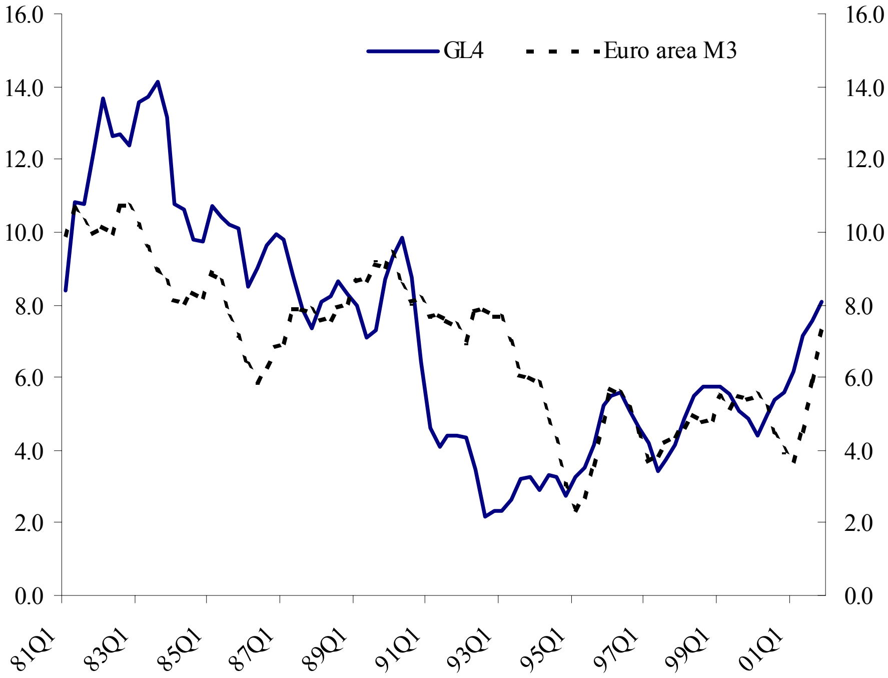

Figure 1: Broad monetary aggegate in G5 excluding euro area (GL4) and euro area M3 (annual growth rates)

rates (GL4) and euro area M3 growth. There is a clear co-movement between broad money growth in the euro area and abroad. With the exception of few years in the early 1990s (perhaps related to the ERM crisis and the slowdown in M2 in the US which led to instability in money demand in that period), there is a positive correlation between the two series, suggesting the existence of a mechanism able to correct international differentials in monetary growth through changes in the exchange rate and/or the monetary aggregates of the different countries. The co-movement of the two series has been remarkably close in recent years.

Figure 2 shows the developments in the nominal and real global liquidity aggregate (including also the euro area (GL5)) and respectively the global inflation rate (measured by the annual growth rate of the GDP deflator) and global real GDP growth. The left panel display an overall positive correlation

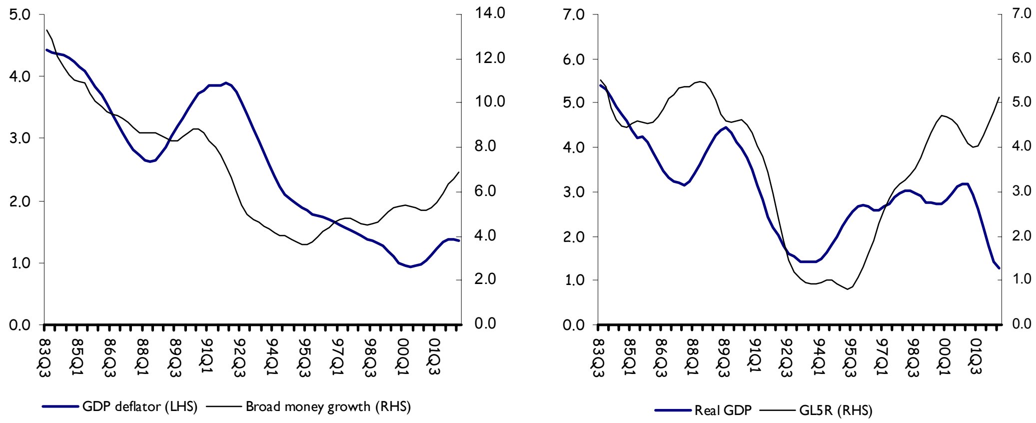

Figure 2: Global liquidity (GL5), inflation, real GDP and real global liquidity(GL5R) growth (four quarter moving average of annual growth rates)

between global inflation and global liquidity, though there are several periods in which the development in the two variables appear to be unrelated. The chart also suggests that the decline in the growth of global liquidity preceded the disinflationary period in the first half of the 1990s. The relation between the two variables from mid-1995 onwards is not so clear as while the growth of global liquidity increased, global inflation continued to decline and started to rise only in 2001.

Real global liquidity is also positively correlated with real economic activity. A recent exception is the period from mid-2001 onwards, during which the annual growth of real global liquidity increased substantially while global real GDP growth declined significantly. The strong turbulence in financial markets, notably following the 11 September terrorist attacks and, more recently, related to the worldwide heightened economic, financial and geopolitical uncertainty, seems to have led to an increased preference for liquid and safe assets, such as those included in the global broad monetary aggregates.

3 Empirical framework

In this paper we rely on the structural VAR methodology, which has been largely used in the economic literature on monetary policy. In particular, it allows for modelling non-recursive structures of the economy with a parsimonious set of variables and it is a useful instrument in the study of business fluctuations. Moreover, it addresses the problem of the interpretation of contemporaneous correlations among disturbances in the traditional reduced-form VAR analysis.[1]

Consider the following reduced form model:

$$\Gamma(L)\,Y_t = u_t \tag{1}$$

where Y_t is an $n \times 1$ vector of macroeconomic variables and $\Gamma(L)$ is a matrix polynomial in the lag operator L for which $\Gamma(L_0) = I$. The standard hypotheses hold for the residuals:

$$E(u_t) = 0 \tag{2}$$

$$E\left(u_t u_s^{'}\right) = \begin{array}{ll} \Sigma & \text{when } t = s \\ 0 & \text{when } t \neq s \end{array}. \tag{3}$$

Condition (3) implies that there is no serial correlation among disturbances but, at the same time, contemporaneous correlation is allowed. In a standard VAR framework, simultaneous relationships are then condensed in the variance-covariance matrix Σ, making the economic interpretation of these relationships quite difficult.

In order to transform the original VAR into a model in which disturbances are orthogonal, Sims (1980) proposed to rely on the Cholesky decomposition of the variance-covariance matrix, through a lower-triangular matrix P such that $\Sigma = PP^{'}$. However, the Cholesky decomposition is not an a-theoretical approach. The lower triangularity of P implies a recursive scheme among the variables (the Wold causal chain) that has clear economic implications and has to be empirically tested as any other relationship.

In this context the SVAR approach goes a step further by reversing the process and by starting from the "true" structural form model. For the same vector Y_t of variables in (1) consider the following dynamic model:

[1] For a comprehensive text-book reference see Amisano and Giannini (1997).

$$A(L)Y_t = Be_t \tag{4}$$
$$A(L) = A + \sum_{i=1}^{k} A_i L^i$$

where A and B are $n \times n$ non singular matrices and e_t is the vector of the "true" structural shocks, which are orthogonal and with unit variance. The lag-lenght of the model is denoted by k.

The contemporaneous relations are explained directly in A and indirectly in B. There are no assumptions on the elements of B, so that the structural disturbances might enter more than one equation. In particular, the structural model is linked to the reduced form (1) by:

$$A_i = -A\Gamma_i \tag{5}$$
$$Au_t = Be_t \tag{6}$$
$$E\left(Au_tu_t^{'}A^{'}\right) = A\Sigma A^{'} = E\left(Be_te_t^{'}B^{'}\right) = BB^{'}. \tag{7}$$

Given that Σ is a symmetric matrix, the maximum likelihood estimates of the reduced form model give rise to an insufficient number of parameter for the exact recovering of the structural form.[2] The SVAR methodology suggests to impose restrictions only on the contemporaneous structural parameters (those contained in A and B), so that reasonable economic structures might be derived. That is why structure (6) is usually know as the AB model.

An example of the use of this model is provided in Bernanke and Mihov (1998) in their study of US monetary policy transmission mechanism. However, also particular cases of the generic AB specification have been used in the applied economic literature. Letting $A = I_n$ one obtains the so called C model (in which $B = C$):

$$\Gamma(L)Y_t = u_t$$
$$u_t = Ce_t \tag{8}$$

in which the contemporaneous link among variables is not explicit but hidden in the relations among structural and reduced form innovations.

[2] In the structural form of the generic model of lag-lenght k there are $2n^2 + kn^2$ free parameters belonging to A, A_i and B, while from the estimates of Γ_i and Σ one gets only $kn^2 + n(n+1)/2$ values.

By imposing $B = I_n$ one gets the K model, (in which $A = K$):

$$K\Gamma(L)Y_t = Ku_t$$

$$Ku_t = e_t. \tag{9}$$

Contemporaneous relations among variables are now modelled in the K matrix, while each structural shock is allowed to influence only one variable.[3]

Finally, note that also the Cholesky procedure is a specific case of the AB model. In particular, it belongs to the K model, in which it is imposed $A = P^{-1}$ lower triangular.

4 Two benchmark models for the euro area

In this section we propose two benchmark schemes to analyze the monetary policy transmission mechanism within the euro area. As introduced in Section 3, the SVAR procedure requires the introduction of some assumptions on the structural model of the economy. In particular, the reaction function of the monetary authority has to be specified. This feedback rule explains the endogenous response of the monetary authority to changes in a given set of variables and thus relates policy-makers' actions to the state of the economy. This in turn implies making assumptions about which variables the monetary authority looks at when setting its operational instrument. However, the basic idea underlying the model is that not all changes in the central bank policy stance reflect the systematic response to variations in the state of the economy: the unaccounted alteration is formalized with the notion of monetary policy shock. The most common interpretation of a policy shock is an exogenous change in the preferences of the monetary authority, due, for instance, to a shift in the relative weight given to inflation and unemployment.[4]

The first scheme (Model 1) we propose to identify monetary policy shocks derives from Kim (1999). Kim's model is an ideal starting point for euro area aggregate analysis, since it is based on a common set of identifying

[3] This specification scheme is probably the most used in the monetary policy analysis: see among others Gordon and Leeper (1994), Sims and Zha (1998), Leeper and Roush (2003) for the US and Kim and Roubini (2000), Dedola and Lippi (2000), Mojon and Peersman (2003) for other countries.

[4] See Christiano, Eichenbaum and Evans (1998) for possible alternative explanations.

restrictions that worked well for the G7 countries. It shows the following non-recursive structure of the kind $Ku_t = e_t$:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ 0 & 0 & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^{YR} \\ u_t^{PI} \\ u_t^{M3} \\ u_t^{SR} \\ u_t^{ER} \end{bmatrix} = \begin{bmatrix} e_t^{YR} \\ e_t^{PI} \\ e_t^{M3} \\ e_t^{SR} \\ e_t^{ER} \end{bmatrix} \tag{10}$$

where YR is the real GDP, PI is the consumer price index, $M3$ is the broad monetary aggregate, SR is the short-term rate, which we assume the monetary authority can freely adjust, and ER is the real effective exchange rate. Both the reduced form and the structural residuals are assumed to follow a standard normal distribution and have a zero mean and a constant variance.

The first two equations indicate that the real sector reacts sluggishly to shocks in the financial variables. The general assumption is that GDP and prices respond to financial signals (money, interest rate and exchange rate) only with a lag. For instance, within the quarter firms do not change their output and prices in response to unexpected changes in financial variables or monetary policy due to adjustment costs. The third equation is a money demand function. The demand for money balances depends on real income, the price index and the short-term interest rate, so that only the exchange rate does not enter contemporaneously the money demand equation. The fourth relationship models the reaction function of the monetary authority, which sets the interest rate after observing the current value of money and the exchange rate. As in Sims and Zha (1998), the choice of this monetary policy feedback rule is based on the assumption of information delays that do not allow the monetary policy to respond within the same period to price level and output developments. That is: published data on money and the exchange rate are available within the period but reliable data on output and prices are not. Finally, in the fifth equation the exchange rate, being an asset price, reacts immediately to changes in all the other variables.

The second specification (Model 2) is based on a recursive identification scheme based on the Cholesky decomposition:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^{YR} \\ u_t^{PI} \\ u_t^{M3} \\ u_t^{SR} \\ u_t^{ER} \end{bmatrix} = \begin{bmatrix} e_t^{YR} \\ e_t^{PI} \\ e_t^{M3} \\ e_t^{SR} \\ e_t^{ER} \end{bmatrix}. \quad (11)$$

The Cholesky scheme (11) implies, in particular, that monetary policy shocks have no contemporaneous effect not only on output and prices as in model (10), but also on money. They affect the exchange rate within the same quarter, but the policy interest rate does not respond to contemporaneous changes in the exchange rate.[5]

The estimations are based on quarterly data, obtained as averages of monthly data, for the euro area from 1980 Q1 to 2001 Q4. Data are expressed in logarithmic form and are seasonally adjusted, except the interest rates which are in levels. A constant and a linear trend are added to both models. Standard information tests suggest to adopt a 4-lag length for both VARs. As in the reference studies, in this paper we do not perform an explicit analysis of the long run behaviour of the economy. Nevertheless, the specification in levels allows for implicit cointegrating relationships in the data (Sims, 1990), i.e. we are implicitly assuming that the variables are jointly covariance stationary.[6]

Figures (3) and (4) display the estimated impulse responses to an unexpected temporary monetary policy shock in both models.[7] A 1-time standard deviation increase in the short-term rates is followed by a real appreciation of the exchange rate and a temporary fall in the real GDP. The effect on output reaches the peak after 4 to 6 quarters and returns to baseline afterwards. Prices respond much more sluggishly, and the effect of the shock is only significant in the case of Model 2. Within the first year the impact on

[5]The Cholesky approach has been followed by Peersman and Smets (2003) in their analysis of euro area monetary transmission mechanism. The main difference with the VAR model used in this study is that they include also a vector of exogenous variables containing a commodities price index and the real GDP and short-term nominal interest rate of the US.

[6]In fact, the examination of the residuals of the VARs reveals no evidence of non-stationarities. The same applies for the other VAR models including global liquidity used in this study.

[7]The confidence bands are obtained through a standard bootstrap procedure with 100 draws.

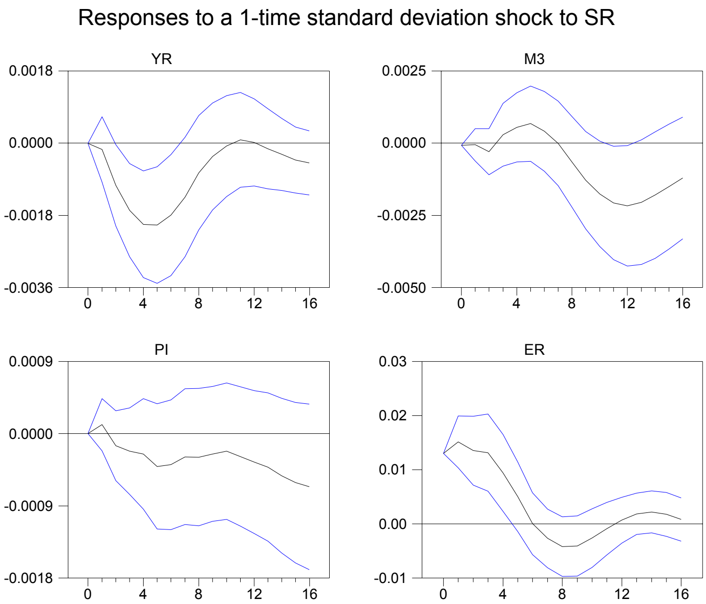

Figure 3: Impulse responses from Model 1 (including 90% confidence bands)

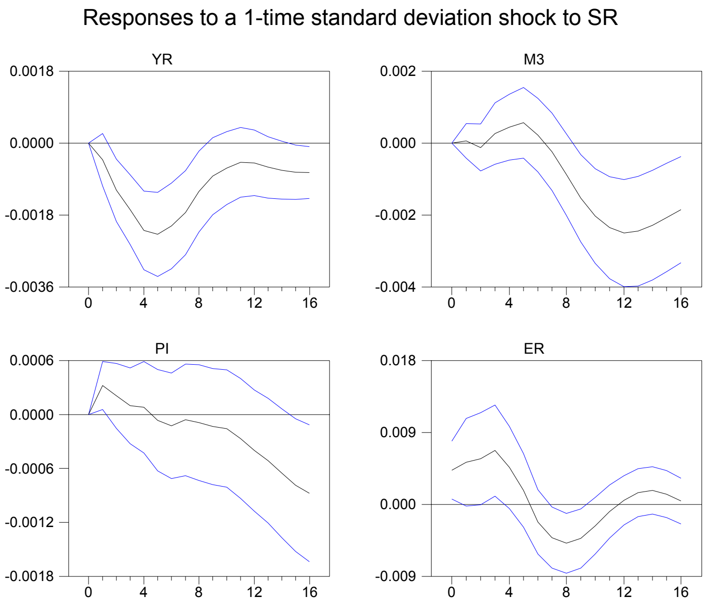

Figure 4: Impulse responses from Model 2 (including 90% confidence bands)

M3 is negative, even though it becomes significant only from the end of the second/beginning of the third year.

A typical monetary policy shock is 30 basis points in both models. The maximum impact of the shock on GDP is just above 0.2%, slightly larger than in Peersman and Smets (2003), which estimated a drop in GDP of 0.15%, but smaller than in Monticelli and Tristani (1999), for which the decline was 0.4%. All in all, the estimated responses are very close to expected movements of macro-variables in a monetary policy tightening setting. Thus, the results support the validity of the identifying assumptions for both models.

The forecast error variance decomposition of the five variables of the model due to shocks to the short-term interest rate and M3 are reported in Table 1. As in most of the VAR literature, the contribution of unexpected shocks in short-term rates to output and price developments are rather limited.[8] For both models the contribution of an innovation in interest rates to output fluctuation is at most 15% at any horizon. This result is close to that reported by Peersman and Smets (2003) and consistent with the findings of Kim (1999) for single G7 countries.

Table 1. Contribution of shocks to the forecast error variance

	shock to SR				shock to M3			
	1 year	2 year	3 year	4 year	1 year	2 year	3 year	4 year
				Model 1				
YR	5.5	11	10	9.2	2.1	6.6	6.8	6.4
PI	0.4	0.8	0.6	0.9	6.3	16	23	24
$M3$	0.5	1.3	3.3	4.6	89	63	37	30
SR	44	27	21	18	4.3	8.7	12	11
ER	39	38	37	39	0.2	0.5	4.3	5.5
				Model 2				
YR	6.5	15	14	14	1.9	6.1	6.3	5.9
PI	0.9	0.4	0.4	1.4	6.4	16	23	24
$M3$	0.2	0.5	5	7	90	63	37	30
SR	61	36	28	25	4.9	8.4	11	10
ER	6.2	7.3	8.7	8.8	0.2	0.5	4.2	5.4

The impact of a shock to M3 is somehow stronger: after 4 years the

[8] See Canova and De Nicoló (2002) for the opposite result.

relative contribution to price fluctuation is 24% for both models. As for the effective exchange rate variability, the relative contribution of an interest rate innovation is larger in the SVAR model than in the recursive approach. While in the latter the contribution is always below 10%, in the former it represents from 37% to 39% of the overall fluctuation at any horizon.

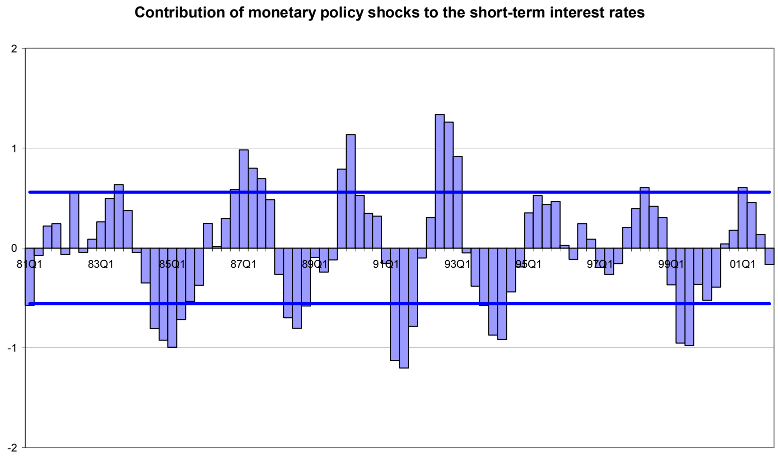

Figure 5: Historical decomposition (Model 1)

Figures (5) and (6) depict the historical contribution of the monetary policy shocks to the short-term interest rate in the euro area as identified by the two models. Even though the magnitude of the swings are sometimes different, the overall picture provided by the recursive and the structural approach is indeed similar.[9]

Over the period from 1981 to 2001 the two models signal contemporaneously a "tight" stance of the euro area monetary policy in three occasions. In fact, the contribution of the monetary policy is above one time the standard deviation for at least two consecutive quarters in the episode of 1987, 1989-90 and 1992-93.[10] There are as well four episodes of "easy" monetary policy:

[9] The correlation coefficient between the two series is 0.89; the standard deviation is slightly larger for model (11): 0.59 versus 0.56.

[10] Only the recursive approach signals a breaching of the 1-time standard deviation threshold in 1983 Q3-Q4 and in 1998 Q1-Q2.

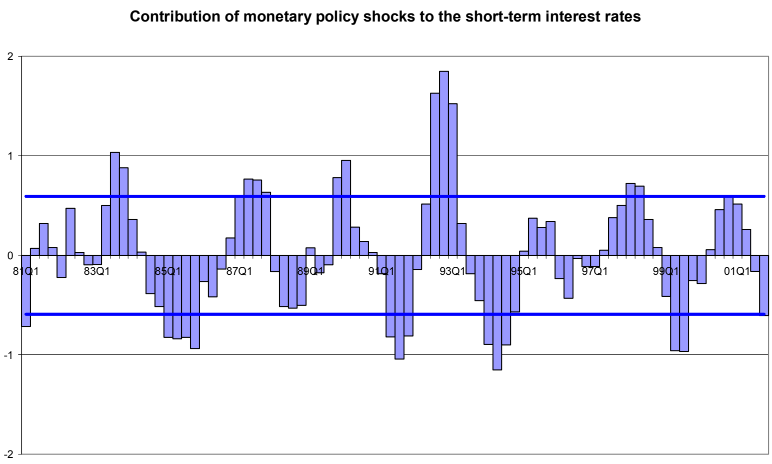

Figure 6: Historical decomposition (Model 2)

1984-85, 1991, 1993-94 and 1999.[11] Again, the finding is consistent with the results from Peersman and Smets (2003): they report positive and negative contribution to the short-term rates in the same periods as in this study even though the oscillations seems to be less pronounced in the second half of the 1990s.

5 Global liquidity spillovers

In order to investigate the possible effect of foreign liquidity on euro area variables, we follow the "marginal" approach as in Kim (2001) by introducing a sixth variable in both benchmark models of the previous section. The variable used ($GL4Y$) is a measure of liquidity outside the euro area corrected for the effect of foreign output (assuming therefore a unit elasticity of money demand with respect to real output in these countries). It is obtained by subtracting the logarithm of real GDP of the four non-euro area countries (US, Japan, UK and Canada) from the logarithm of the weighted sum of monetary aggregates of these countries ($GL4$).[12] Again, we use quarterly

[11] In this case the non-recursive approach signals an additional episode in 1988 Q1-Q2.

[12] The use of cross-country aggregated data in the econometric analysis of international spillovers is not new in the literature. For recent applications see Kwark (1999), Kim

data obtained as averages of monthly data.

The choice of the marginal approach instead of a full VAR including other relevant foreign variables (foreign output, interest rates and prices) was dictated by the relatively small size of the sample used (84 observations). By using money per output, we assume that only the part of global liquidity not linked to foreign output is assumed to potentially have spillover effects on the euro area.

We order the extra variable $GL4Y$ in the models of the previous section as the most exogenous variable in the system. Under this assumption, we are implicitly assuming that developments in the euro area do not have a contemporaneous effect on global monetary developments but only a delayed one.[13]

When Model 1 is used, the identification scheme (Model 1a) becomes:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} & 0 \\ a_{51} & 0 & 0 & a_{54} & 1 & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} u_t^{GL4Y} \\ u_t^{YR} \\ u_t^{PI} \\ u_t^{M3} \\ u_t^{SR} \\ u_t^{ER} \end{bmatrix} = \begin{bmatrix} e_t^{GL4Y} \\ e_t^{YR} \\ e_t^{PI} \\ e_t^{M3} \\ e_t^{SR} \\ e_t^{ER} \end{bmatrix}. \qquad (12)$$

The plot of the impulse responses is shown in Figure 7. A positive shock to global liquidity per output results in a permanent rise in the levels of both euro area M3 and prices. As regards the effect on real GDP, there is a temporary upward effect of a positive shock to global liquidity on the output level of the euro area, with GDP returning to baseline after a period of about five years. Therefore, shocks to global liquidity per output seem to have only nominal effects in the long-run.

(2001) and Lumsdaine and Prasad (2003).

[13] The choice of including global liquidity in the euro area benchmark VARs as a fully exogenous variable could also be considered. However, the results of exclusion tests in the extended six-variable VAR show that it is possible to reject the null that global liquidity is exogenous to euro area variables. In addition, it is also possible to reject the hypothesis that the euro area block is exogenous to global liquidity. Therefore, we have opted to keep global liquidity endogenous. On the other hand, we have added a total commodities cost variable as an exogenous variable, to take account of movements in global commodities prices. The inclusion of this variable therefore controls for a further source of external shocks that may distort the link between global liquidity and inflation and output in the euro area.

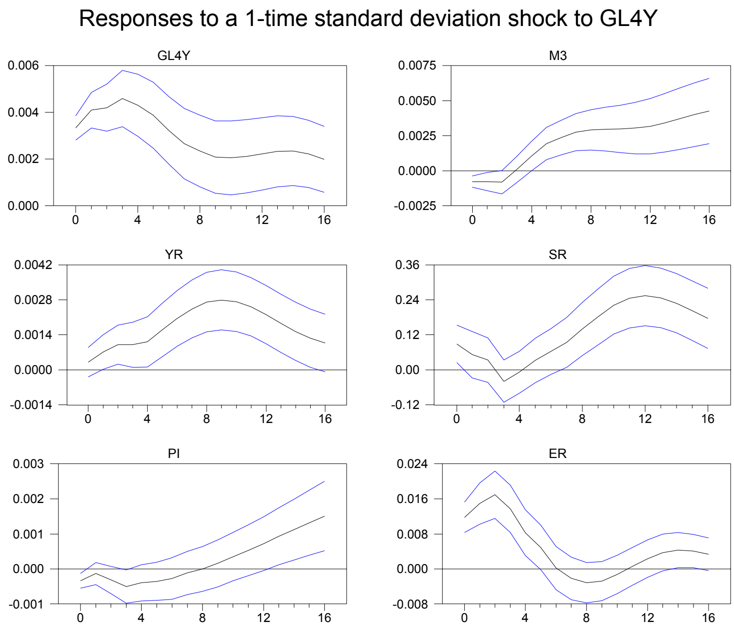

Figure 7: Impulse responses from Model 1a (including 90% confidence bands)

Also for the identifications based on the Cholesky decomposition, we introduce $GL4Y$ as the most exogenous variable in the system (Model 2a), following the chain $GL4Y \rightarrow YR \rightarrow PI \rightarrow M3 \rightarrow SR \rightarrow ER$. The impulse response functions are shown in Figure 8. The dynamics are indeed similar to those from Model 1a: a positive shock to global liquidity leads to a significant rise in euro area M3 and to an upward effect on prices, suggesting that there is a transmission from global monetary developments to the euro area over time. In particular, these developments point to a positive spillover effect into the euro area as predicted by the "push" channel. An unexpected increase in money abroad gives rise to capital flows into the euro area in the mid-term determining an upward pressure on M3, which in turn leads to an increasing price pressure.

As regards output, an exogenous increase in global liquidity leads to a significant upward effect on euro area output after two quarters. The effect peaks at around two years and then declines becoming insignificant in the longer-run. The short-term interest rate does not appear to react much in the short-run but it rises significantly after a period of about one year. One possible interpretation is that the upward movement of the interest rate reflects a monetary policy reaction to the increase in the price index associated to the positive spillover of global liquidity. Finally, a positive shock to global liquidity leads to a temporary upward effect on the euro exchange rate.[14]

Overall, these findings are consistent with the existence of a push channel, through which high monetary growth abroad determines an increase in the demand for assets in domestic markets and leads to stronger M3 growth and higher returns.

Next we analyze the variance decomposition of the forecast error variance of M3, prices and real GDP for models 1a and 2a. Starting with Model 1a the variance decomposition for M3 suggests that, besides shocks to M3 itself, shocks to the short-term interest rate are the most important source of fluctuations in the monetary aggregate over the 1-year horizon. However, their importance declines over time (see the Table 2, upper panel). By contrast, global liquidity has a small contribution to the variability of M3 in the short-run but it gradually increases over time becoming the most important

[14] As a robustness check we looked at the impulse responses when global liquidity is introduced in the model as the most endogenous variable. The shape and the size of the responses do not change significantly, both in the non-recursive and in the Cholesky identification scheme.

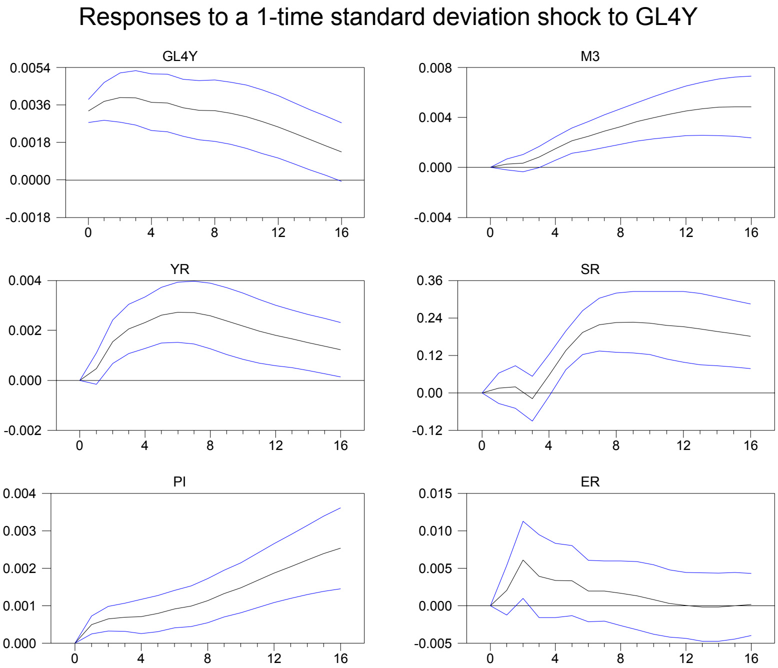

Figure 8: Impulse responses from Model 2a (including 90% confidence bands)

variable in the longer-run, after shocks to M3 itself. As regards Model 2a, the results are somewhat different as in this case innovations to the short-term interest rate do not play an important role in explaining M3 fluctuations. Instead, global liquidity plays a strong role also in the short-run, being the most important variable in explaining the variability of M3 at any horizon, again excluding M3 itself.

Table 2. Forecast error decomposition

	Model 1a				Model 2a			
	1 year	2 year	3 year	4 year	1 year	2 year	3 year	4 year
				Variability of M3				
GL4Y	2.4	15.4	26.8	33.7	14.4	44.6	58.8	64.8
YR	0.6	1.3	11.0	16.6	1.0	1.4	5.9	6.5
PI	4.9	3.1	2.4	1.9	4.8	5.4	4.8	3.8
M3	79.5	67.1	49.7	36.2	79.1	47.3	26.8	17.2
SR	10.4	9.8	6.3	4.4	0.5	1.0	2.8	5.6
ER	2.1	3.4	3.9	7.3	0.2	0.3	0.8	2.1
				Variability of prices				
GL4Y	6.0	4.6	4.3	12.4	4.1	8.2	20.0	36.6
YR	0.2	0.2	2.4	8.4	1.6	1.2	1.2	2.6
PI	52.6	32.8	23.6	17.0	73.4	61.4	48.9	35.1
M3	14.3	31.6	40.5	38.7	8.6	17.2	19.7	16.8
SR	18.3	24.1	23.1	16.6	0.7	0.8	0.5	1.0
ER	8.5	6.8	6.1	6.9	11.5	11.2	9.7	7.8
				Variability of real GDP				
GL4Y	5.7	19.2	38.4	40.8	18.1	40.6	55.7	57.9
YR	74.0	54.6	41.0	37.8	65.2	36.8	26.8	24.3
PI	7.6	5.1	3.9	3.4	4.4	2.7	2.1	1.9
M3	0.6	3.8	3.4	3.2	0.4	1.1	1.1	1.2
SR	4.8	8.2	6.5	6.2	9.9	17.2	13.2	13.0
ER	7.2	9.1	6.7	8.6	2.0	1.6	1.1	1.8

The middle panel of Table 2 shows the forecast error decomposition for prices. M3 plays an important role in explaining the forecast error variance in both models, particularly in Model 1a. Again, the main difference between the two models concerns the importance of shocks to the short-term interest rate. In fact, in Model 1a shocks to short-term rates are important in explaining the variability of the price level, even in the longer-run. In addition, their contribution is always larger than that of shocks to global liquidity. By contrast, in Model 2a global liquidity appears to be the most important contributor to the variability of price level in the long-run, with a share of 36.6% at a horizon of four years.

Finally, the decomposition of the forecast error variance for output is shown in the lower panel of Table 2. As in the case of the euro area models, in Model 1a the contribution of the short-term rate to the variability of real output is relatively limited. In Model 2a shocks to the short-term rate explain a share of 17.2% of GDP variability after two years and remain well above 10% thereafter. As for international money, both models suggest that while in the short-run shocks in global liquidity play a small role in influencing output fluctuations in the euro area, the importance increases over time with global liquidity becoming relevant in the long-run.[15]

Overall, the analysis suggests that the impulse responses to shocks to global liquidity are quite robust to the type of specification that is chosen. The results highlights that a positive shock to global liquidity leads to a rise in euro area M3 and in the price level in the euro area. The effect on euro area real GDP is found to be positive and temporary, with a return to baseline four years after a shock to global liquidity. As regards the forecast error variance decompositions, the results suggest that global liquidity plays an important role in explaining fluctuations in M3, prices and output in the euro area. However, as regards prices, the evidence is not conclusive on the relative importance of global liquidity and interest rates. In particular, while in Model 1a global liquidity plays a limited role, it is quite important in Model 2a.

[15] The result that global liquidity per output is the main cause of the euro area output volatility in the longer-run is somewhat above what would be expected. One possible explanation for this finding is that shocks to global liquidity per output may capture also shocks to global demand. However, when other international variables are introduced in the benchmark models (global GDP and global interest rate outside the euro area), the contributions to the variance are always rather limited, thus suggesting that global liquidity is indeed an important source of variability for some euro area macroeconomic variables.

6 A global approach

In this section we try to model global liquidity within a world-wide context. In particular we try to identify a common monetary policy shock in an enlarged G5 framework. Of course we are aware that there is neither a common monetary policy nor any broad policy coordination at such aggregate level. However, this approach might help in solving the problem of endogeneity in open-economy single country models. In fact the possible endogeneity from monetary policy shocks derives from a “following the leader” behaviour by which a given country (the follower) always adjusts its monetary policy stance accordingly to the decisions of a leader. Thus, shock to monetary policy in the “follower” economy might not be exogenous but only a reaction to the “leader country”. Grilli and Roubini (1995) find some evidence of US being the leader internationally at the G7 level, while many applications for EU countries suggest that Germany has been, at least for the ERM-period, the European leader.[16]

The vector of endogenous variables is as follows:

$$Y_t = [YR5_t, PI5_t, GL5_t, SR5_t, TC_t]$$

where $YR5$ is the real GDP, $PI5$ is the consumer price index, $GL5$ is the monetary aggregate and $SR5$ is the average short term interest rate of the G-5 area, whereas TC is a commodities price index.

We propose the two specifications introduced in Section 4 also for this kind of analysis (Model 1b and Model 2b). In fact, as already noted, these two specifications broadly rely on models that were already “tested” at international level: the first by Kim (1999) for the G7 countries, the second by Peersman and Smets (2003) for the Euro area and the US. The time horizon ranges again from 1980 Q1 to 2001 Q4.[17]

Figure (9) shows the impulse response functions to an unexpected monetary policy shock.[18] We can see in particular that real GDP decreases at impact but then tends to recover to its initial level and that global liquidity quickly drops after an increase in short-term rates and the effect is long-lasting. Only the price index does not respond in the expected way. The

[16] See for instance Kim and Roubini (2002) and the discussion in Dornbusch et al. (1998).

[17] Moreover, we maintaned the same specification of previous models also as concerns the introduction of a time trend and a constant and the 4-lag order of the VAR.

[18] The impulses responses from the two models are very similar, those reported in Figure (9) and (10) are derived from Model 2.

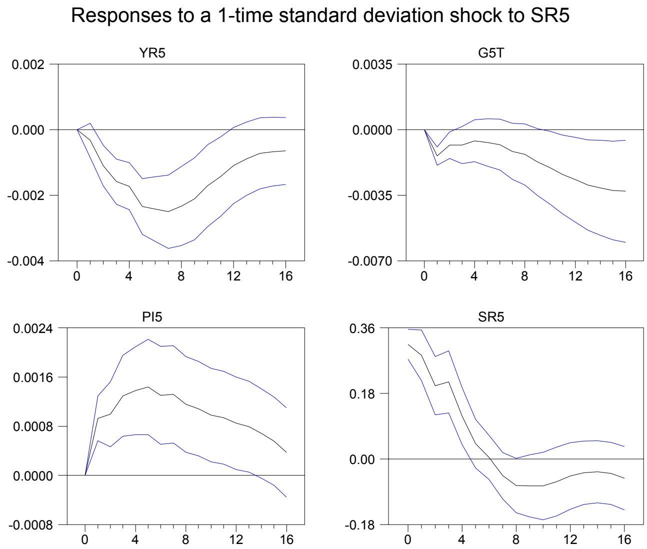

Figure 9: Impulse responses from Model 2b (including 90% confidence bands)

figure highlights a clear "price puzzle": for 2 years prices increase and only thereafter start to decline. This might reflect the difficulty of the model in properly identifying monetary policy shocks. The innovations in short-term rates may reflect other structural shocks in addition to monetary policy innovations. In particular, the absence of an exchange rate term in the specification may result problematic, since G5 countries other than US have been implicitly and explicitly concerned about the effects of a depreciation of their currency on their inflation rates for at least part of the time period we are considering. Thus the model is not able to control for the part of interest rates movements that are systematic responses to a depreciation of domestic currency.

Figure (10) depicts the reaction of real GDP and prices to a shock in the global liquidity. An increase in the global monetary aggregate has a positive impact on real GDP in the short-run, that however disappears in the medium- to long-run. As for prices, the effect is negligible in the first 6 quarters, but soon after becomes significantly positive and permanent. Again the results are akin to those obtainable from a single country model.

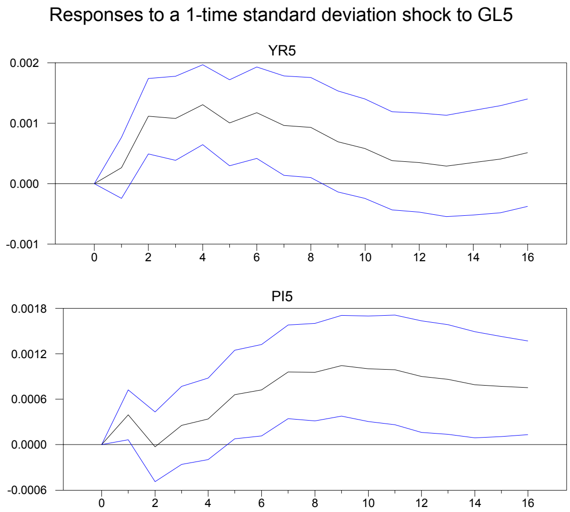

Figure 10: Impulse responses from Model2b (including 90% confidence bands)

In order to have an idea on how the dynamics of the global model are influenced by the times series aggregation procedure here implemented, it might be worth to look at the impulse responses functions country by country. In fact, if the transmission mechanism is similar across the G5 countries, the global approach provides a measure of the effects of a given shock which is as good as that obtainable by other estimation methods.

We adopted the same identification pattern of the global model for the domestic variables in national currency of each country. Once obtained the impulse responses we could then compute the average response to a shock to the monetary policy authority instrument. Following the spirit of the "mean group estimator" proposed by Pesaran and Smith (1995) we averaged the impulse responses by a simple mean. As an example, Figure (11) shows the real output response to a monetary policy shock for the euro area, the US, Japan, the UK and Canada together with the cross-country average and the impulse response coming from the global framework (Model 2). The shape of the curve is indeed similar for the whole group of countries and the two aggregates; only Japan seems to suffer a longer contractionary effect from

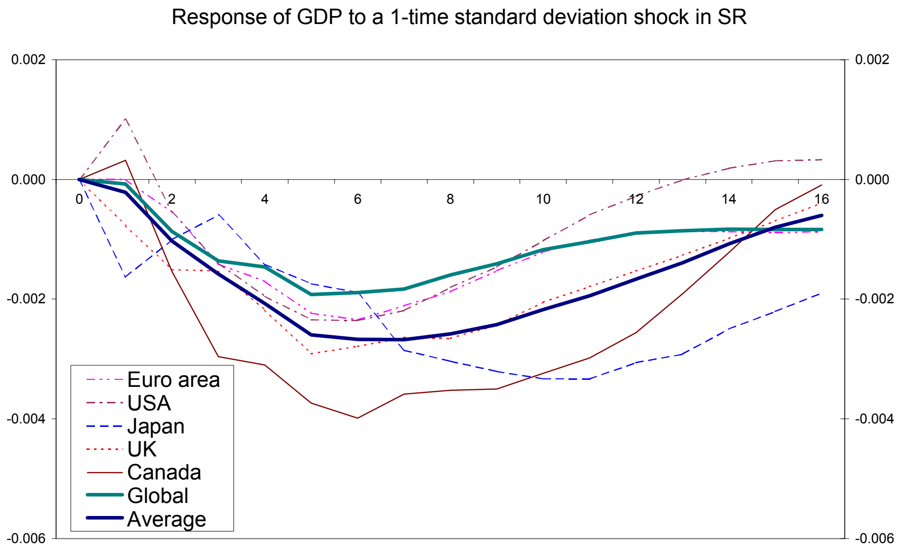

Figure 11: Impulse responses from Cholesky specification (Model 2)

a tightening of the monetary stance. However, the dynamics seems to be similar concerning both the shape and the magnitude of the oscillations when we consider the result of the two aggregations, thus somehow supporting the validity global framework here implemented. This exercise has been repeated for each variable and for both the specifications of the model.

We now analyze the results concerning the sources of output and price fluctuations. As for global GDP (Figure 12), the forecast error variance decomposition shows that the contribution of unexpected shocks to short term rates is rather limited in the short run but it quickly increases over time. At the end of the second year the contribution to output volatility is already above 20% and it remains slightly below that threshold till the end of the sample period. Even though output itself and prices explain always the vast majority of the fluctuations at any horizon, the role of global liquidity and that of commodities price contribute significantly from the second year onwards. Moreover the role of the global monetary aggregate is larger but not far from that recorded by M3 in the correspondent models for the euro area. All in all, the contribution of variables other than prices and GDP are stronger in the global framework than in the two models of Section 4.

Fig (13) depicts the contributions to price fluctuations. As one would

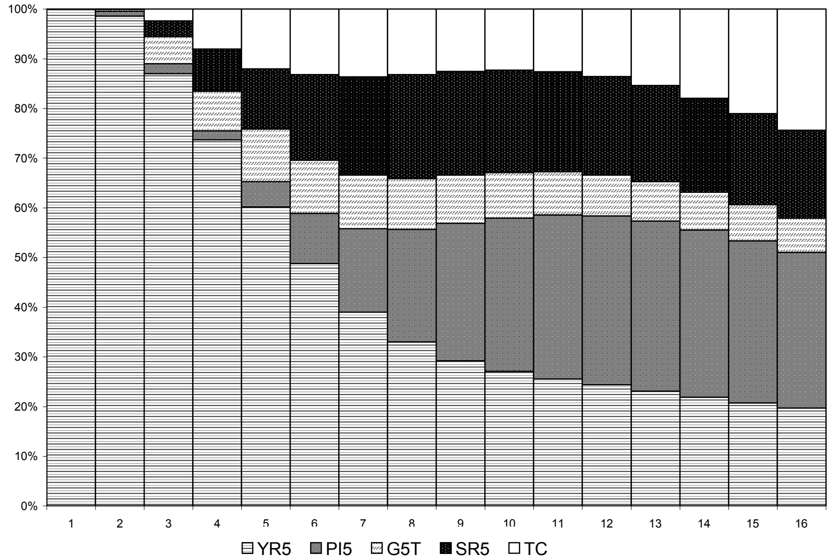

Figure 12: GDP Variance Decomposition

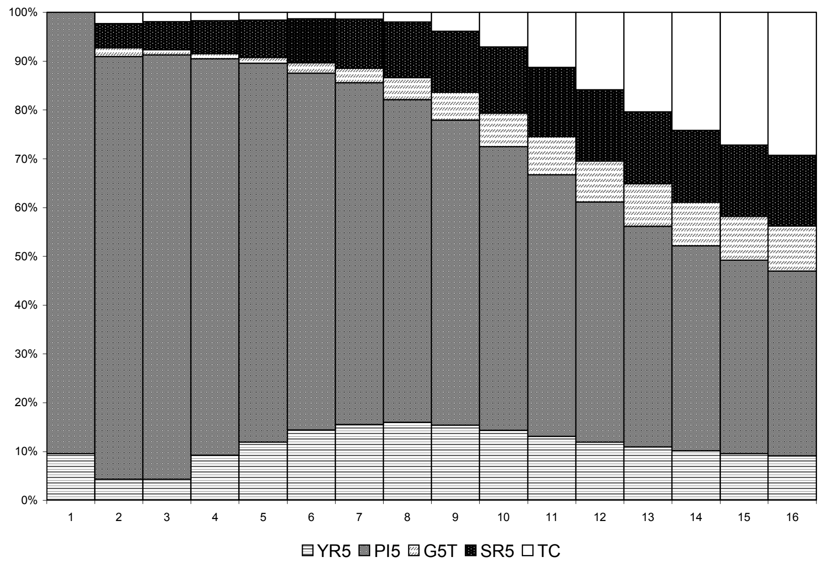

Figure 13: CPI Variance Decomposition

expected, in the short run prices are quite sticky, their own contribution still accounts for more than 2/3 of total volatility at the end of the second year. However, short-term rates, global liquidity and especially commodities prices gain relative weight strongly from the beginning of the third year, reaching a cumulative share of 50% in the last two quarters. The contribution of GDP is relatively small.

7 Conclusion

The paper relied on the SVAR approach to construct two benchmark models of the euro area that seem to appropriately identify exogenous monetary policy shocks. The behaviour of GDP, prices, money and the exchange rate derived from the impulse response functions is consistent with the transmission of a monetary policy impulse. Following the marginal approach of introducing in the models a further endogenous variable, we could check the effects of a global liquidity aggregate on euro area macroeconomic developments. The impulse responses suggest that a positive shock to extra-euro area global liquidity leads to a permanent rise in M3 and the price level and determines temporary increases in euro area output and a temporary appreciation of the real effective exchange rate of the euro.

The relevance of the inclusion of foreign variables in the empirical models analysed here relates to the broad economic integration across-countries already achieved and to the speed at which capital markets are currently able to move funds worldwide. The literature on international business cycle shows that the cross-country transmission of shocks is an important element in explaining domestic output fluctuations. This paper suggests that a similar channel is at work when dealing with monetary aggregates. In fact, our results show that shocks to global liquidity play an important role in explaining price and output fluctuations in the euro area, even if the size of the impact is to some extent sensitive to the specification implemented.

When a recursive scheme is used, both M3 and the foreign monetary aggregate have important explanatory power for the variability of euro area prices. In addition, in the longer-run shocks to global liquidity seem to have a higher importance for the variability of prices than shocks to M3 itself. On the other hand, when a non recursive scheme is at work, global liquidity plays a somewhat smaller role in the short-run in explaining price fluctuations. Nevertheless, also in this model the global monetary aggregate still contributes significantly to price variability at longer horizons.

As for GDP fluctuations, the contribution of global liquidity shocks is increasing over time and soon becomes the most important source of GDP variability. In particular, when the recursive approach is implemented, the portion of output variability explained by foreign money shocks is very large. However, comparing our results with those of Canova and De Nicoló (2002) we can note that the share of the output fluctuation after two years attributable to a global liquidity shock (20-40%) is even smaller than what they report for some European G7 countries due to a "standard" monetary policy innovation.

Thus, the main contribution of this work is that the evolution of foreign variables and in particular of monetary aggregates is relevant for the macroeconomic developments in the euro area.. The evidence reported suggest a possible channel of transmission of global liquidity shocks: robust monetary growth abroad may lead to capital flows into the domestic economy due to the search for different investment opportunities, thus resulting in stronger monetary growth and higher asset returns in the recipient country. In particular, this correlation (positive spillover effects from abroad) in the relationship between foreign and domestic money is labelled as the "push channel".

Finally, we also explicitly modelled a global G5 framework, relying on the same structural identification schemes used for the euro area. The global framework points to a strong similarity in the behaviour of aggregate variables compared to single country models. In particular, after a monetary policy shock output declines only temporarily, with the downward effect reaching a peak within the second year, and the global monetary aggregate drops significantly. In addition, the relative weights of the several variables in explaining output and price fluctuations at a global level are comparable in size with the results obtained in the euro area models.

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A Data annex

The monetary aggregates used in the construction of the broad measure of global liquidity were M3 for the euro area, M2 for the US, M2 plus certificates of deposits for Japan, M4 for the UK and M2+ for Canada. Data on euro area M3 are obtained from the ECB, data on US M2 are obtained from the US Federal Reserve Board (press release H6). Data on monetary aggregates in Japan and Canada are obtained from Bank of Japan and Bank of Canada, respectively. In the case of the euro area data, on consumer prices (corresponding to HICP), the GDP deflator and real GDP are obtained from Eurostat. The data on the short-term interest rate in the euro area corresponds to the three-month interbank interest rate until 29 December 1998 and, thereafter, to the three-month EURIBOR interest rate. For the remaining countries, the data were obtained from the OECD Main Economic Indicators database. The series on total commodity prices is obtained from the Area Wide Model Database corresponding to the Commodity Price Index produced by the HWWA. The real (CPI-based) effective exchange rate of the euro is obtained from the ECB and is based on the aggregation of the bilateral exchange rate of the euro against 12 partner currencies using trade weights. All series are seasonally adjusted except interest rates.

The criterion used for the selection of the broad aggregates for each country was that are the key broad monetary aggregates in the different countries from a monetary policy point of view. The global aggregates were constructed by converting each national aggregate into euros using PPP exchange rates. The formula used is the following:

$$GL5 = \sum_{i=1}^{5} M_i E_{ppp}^{i,eur}$$

where M_i represents each national monetary aggregate and $E_{ppp}^{i,eur}$ is the corresponding country's PPP exchange rate vis-à-vis the euro. The PPP exchange rate is based on relative PPP taking the nominal exchange rate of January 1999 of the several countries against the euro as the basis and using the consumer price indices of the several countries to construct the PPP exchange rate for the other periods. Thus, this procedure does not guarantee that absolute PPP holds. However, for the purpose of this study, the level of the exchange rate used to construct the global liquidity is relatively not important as only the changes over time of the global liquidity aggregate will matter in the estimation of the model.

One possible limitation in the construction of the global liquidity aggregate as done above, is that the resulting aggregate will be rather sensitive to the definition of the monetary aggregate used to construct it. As there are problems of comparability between the aggregates used for the different countries, given the different definitions of monetary aggregates, the weights may not reflect appropriately the differences in the importance of each country. This is particularly the case for Japan and the US, with the former country having over same periods a larger share in the global liquidity aggregate than the latter. Therefore, we have also constructed a different measure of global liquidity using GDP weights. The formula is the following:

$$GL5 = \sum_{i=1}^{5} MIndex_i \frac{GDP_i}{GDP_{all}^{eur}} E_{ppp}^{i,eur}$$

where GDP_i represents nominal GDP of country i expressed in national currency and GDP_{all}^{eur} is the aggregate GDP of the whole set of countries obtained as the sum of each country's GDP converted into euros with PPP exchange rates. $MIndex_i$ is the index of the monetary aggregate in country i. For each country this index equals 100 in January 1999 and grows at the same rate as the monetary aggregates denominated in national currency used for each country.

Figure 14 shows the difference between the two series. As can be seen in the chart, most of the time they quite limited.

In the case of the other variables, namely the short-term interest rate, real GDP and the GDP deflator, the computation of global aggregates was done by relying on GDP weights obtained using PPP exchange rates to convert each national nominal GDP into euro.

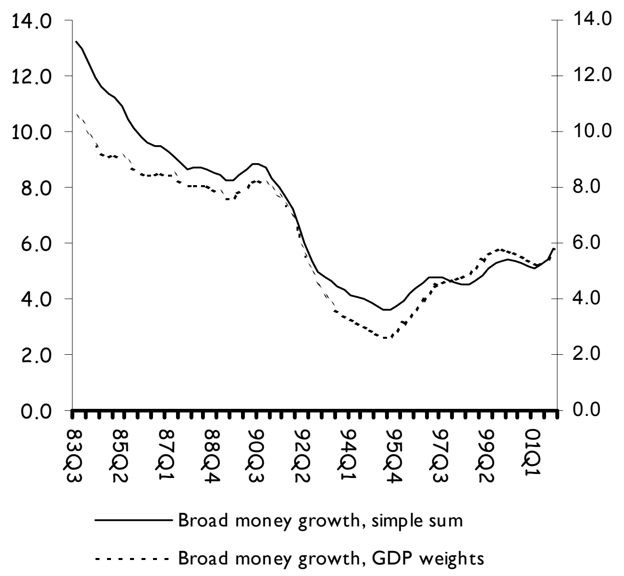

Figure 14: Global liquidity computed with different weights

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