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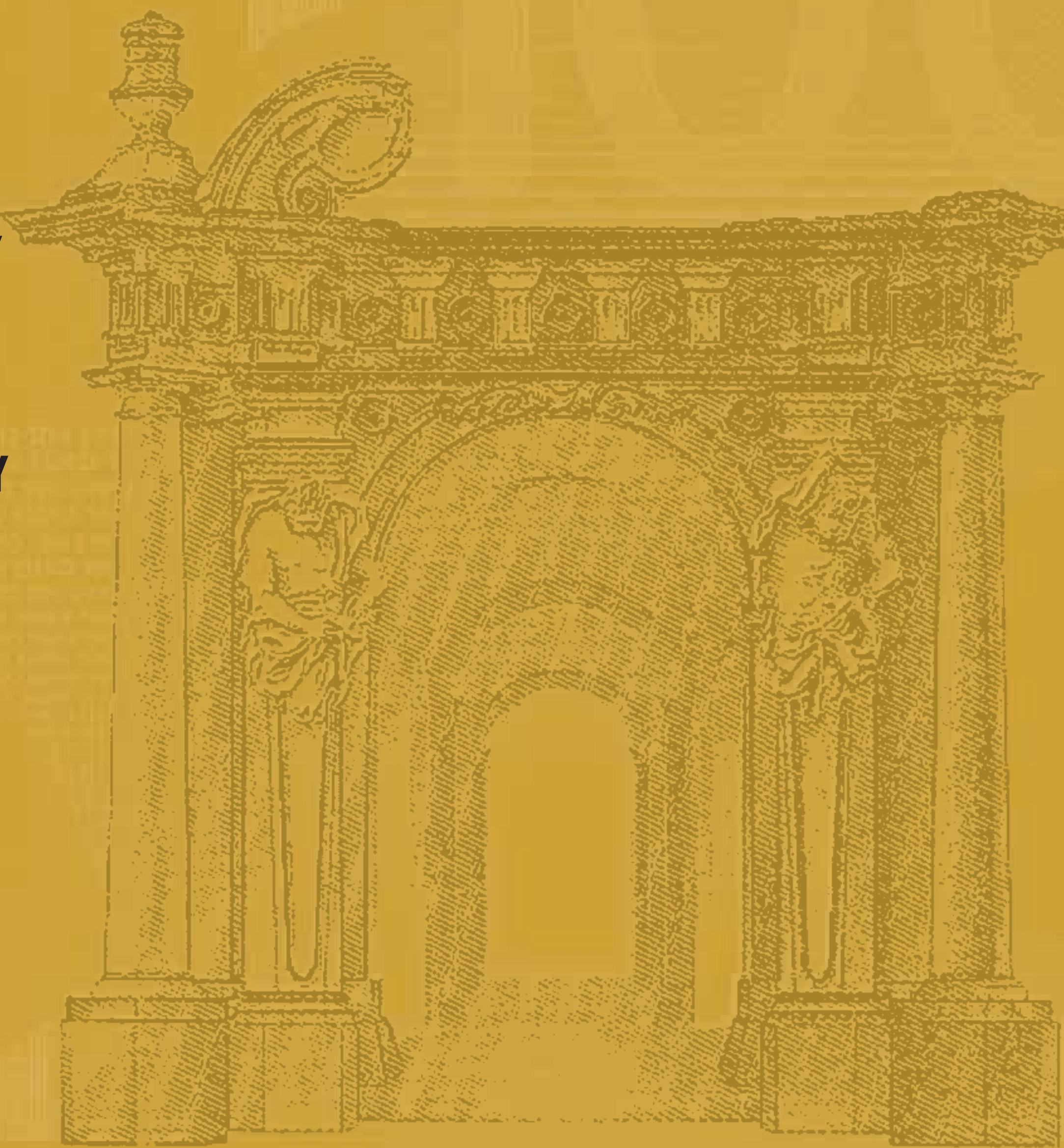

MONETARY POLICY SHOCKS IN THE EURO AREA AND GLOBAL LIQUIDITY SPILLOVERS

by João Sousa
and Andrea Zaghini

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In 2004 all publications will carry a motif taken from the €100 banknote.

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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.

Keywords: Monetary policy, Structural VAR, International spillovers

JEL Classification: E52, F01.

Non-technical Summary

The paper investigates the information content of a global liquidity aggregate, i.e. a global monetary aggregate constructed as a simple sum of the monetary aggregates of the euro area, the United States, the United Kingdom, Japan and Canada converted into euro. Such aggregates may provide relevant information for assessing euro area monetary developments. First, common shocks to money of a global scale might affect monetary aggregates in the same direction in different areas. Second, excess liquidity abroad may influence financial conditions, monetary aggregates and financial asset prices in the euro area via capital flows.

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. 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.

The paper studies the role of monetary aggregates in an international framework within the context of SVARs (structural vector autoregressions). SVARs constitute a convenient way to analyse this role as they take into account the endogeneity of the variables of the different areas. The approach consists in first constructing 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, 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. Our results suggest that developments in global liquidity are relevant for explaining both nominal and real fluctuations in the euro area.

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.[1] 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 role of money as an indicator of macroeconomic development 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

[1] After an early attempt by McKinnon (1982), only recently the literature has recorded contributions in this field (Kim and Roubini; 2000, Kim; 2001, Holman and Neumann; 2002, Canova; 2003)

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 thus to study the international spillover effects on the euro area economy due to changes in foreign monetary aggregates. 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 using only domestic variables (i.e. prices, output, money, 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.

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 two benchmark models for the euro area, Section 5 analyses the impact on euro area macroeconomic variables of a global liquidity shock, Section 6 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 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

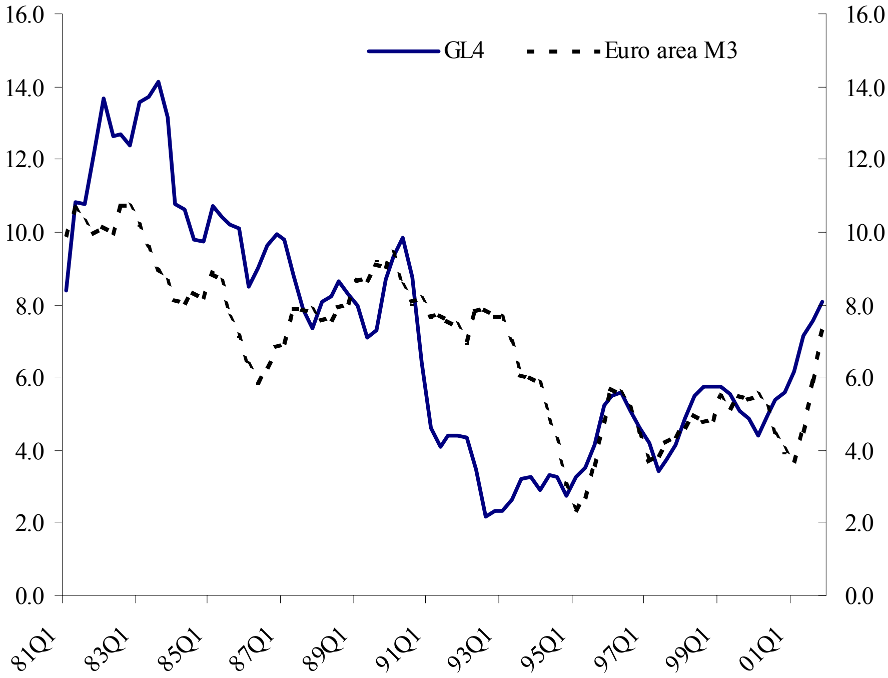

Figure 1: Broad monetary aggegate in G5 excluding euro area (GL4) and euro area M3 (annual growth rates)

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 between global inflation and global liquidity, though there are several periods in which the development in the two variables appear to be unrelated. The

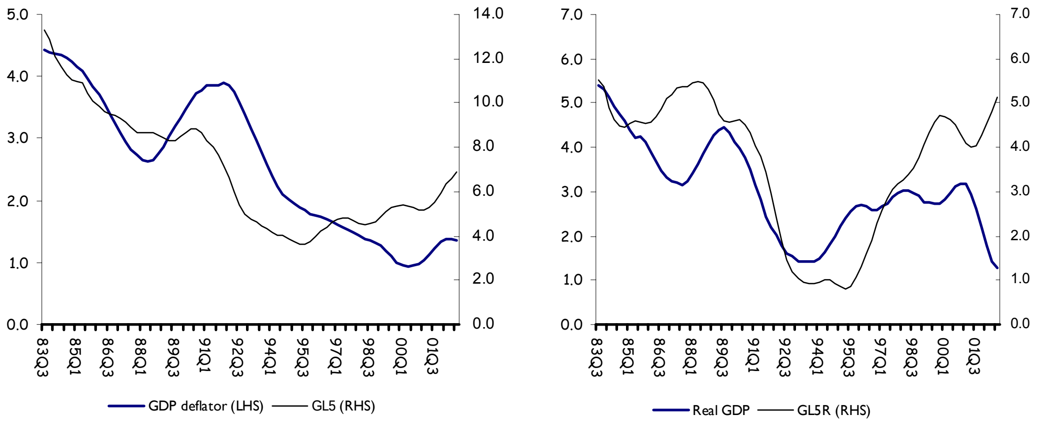

Figure 2: Global liquidity (GL5), inflation, real GDP and real global liquidity (GL5R) growth (four quarter moving average of annual growth rates)

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.

The synthetic preliminary evidence proposed above points to the existence of a possible interaction between international aggregates and domestic euro area variables as well as possible links among global macroeconomic variables. In the rest of the paper we propose a more accurate empirical framework of analysis in which evaluate these relationships.

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 to modelling non-recursive structures of the economy with a parsimonious set of variables and it is a useful instrument in the study of economic fluctuations. Moreover, it addresses the problem of the interpretation of contemporaneous correlations among disturbances in the traditional reduced-form VAR analysis.[2]

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:

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

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

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:

[2] 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:

$$A_i = -A\Gamma_i \tag{5}$$

$$Au_t = Be_t \tag{6}$$

$$E\left(Au_t u_t^{'} A^{'}\right) = A\Sigma A^{'} = E\left(Be_t e_t^{'} B^{'}\right) = BB^{'}. \tag{7}$$

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.[3] 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.

[3] 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.[4]

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.[5]

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

[4]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.

[5]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 model is estimated by maximum likelihood.

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:

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

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.[6]

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.[7]

Figures (3) and (4) display the estimated impulse responses to an unexpected temporary monetary policy shock in both models.[8] 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

[6]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.

[7]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.

[8]The confidence bands are obtained through a standard bootstrap procedure with 500 draws.

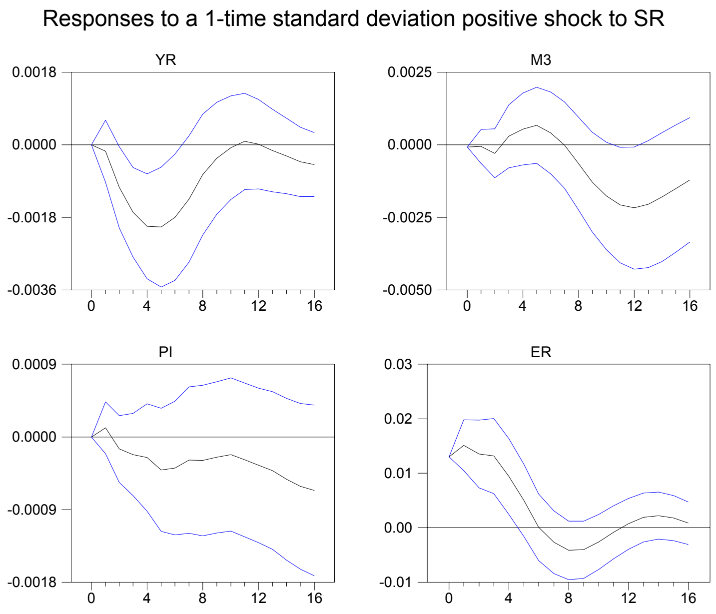

Figure 3: Impulse responses from Model 1 (including 90% confidence bands)

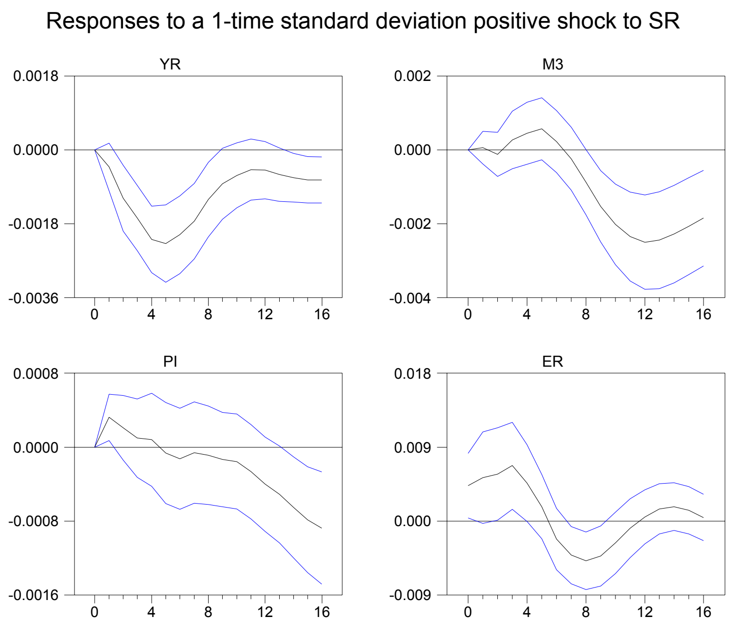

Figure 4: Impulse responses from Model 2 (including 90% confidence bands)

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.[9] 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 SR and M3 to the forecast error variance of each variable

	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

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

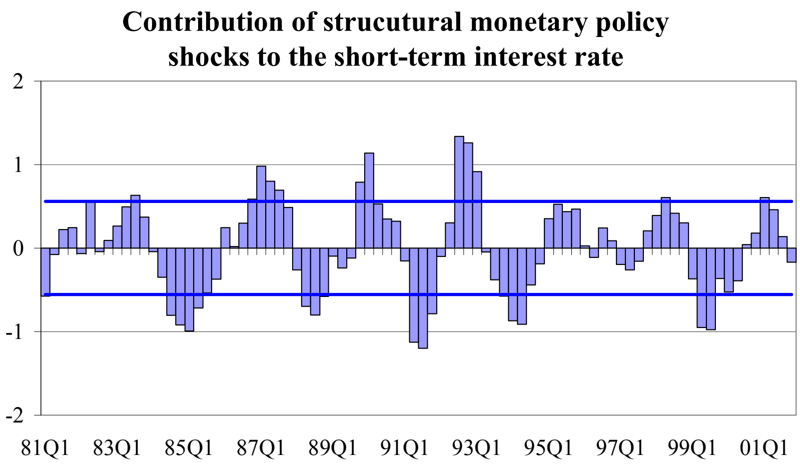

Figure 5: Historical decomposition of SR from Model 1 (including 1-time standard deviation confidence band)

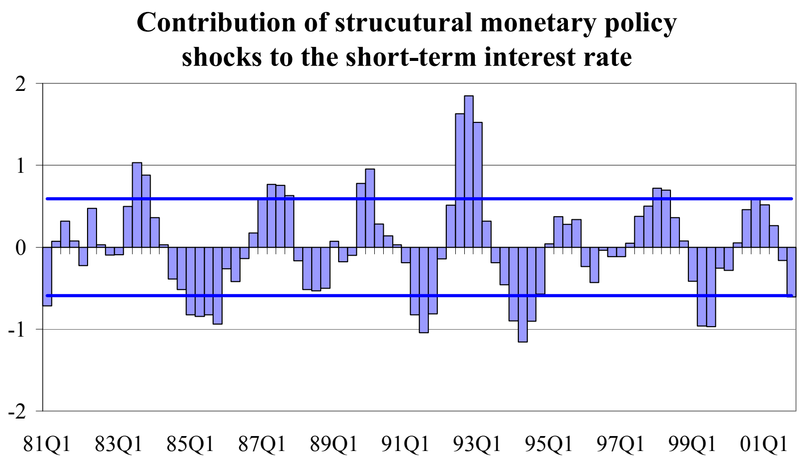

Figure 6: Historical decomposition of SR from Model 2 (including 1-time standard deviation confidence band)

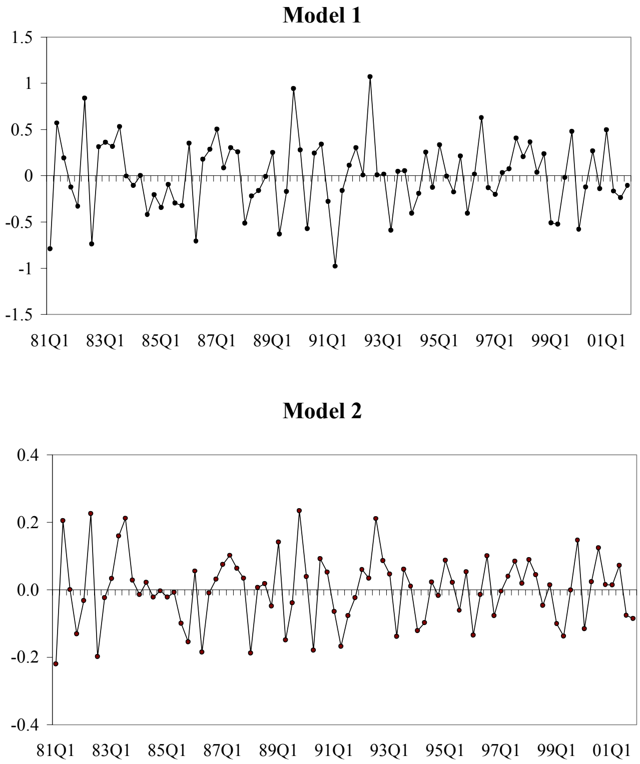

Figure 7: Structural monetary policy shocks

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

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.[10]

[10] The correlation coefficient between the two series is 0.89; the standard deviation is

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.[11] There are as well four episodes of "easy" monetary policy: 1984-85, 1991, 1993-94 and 1999.[12] 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.

For the sake of completeness Figure (7) reports the structural shocks derived from both models.

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 ($GL4$).[13] Again, we use quarterly 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.

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slightly larger for model (11): 0.59 versus 0.56.

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

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

[13] 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 (2001) and Lumsdaine and Prasad (2003).

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.[14]

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

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

The plot of the impulse responses is shown in Figure 8. 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.

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 9. 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

[14] 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.

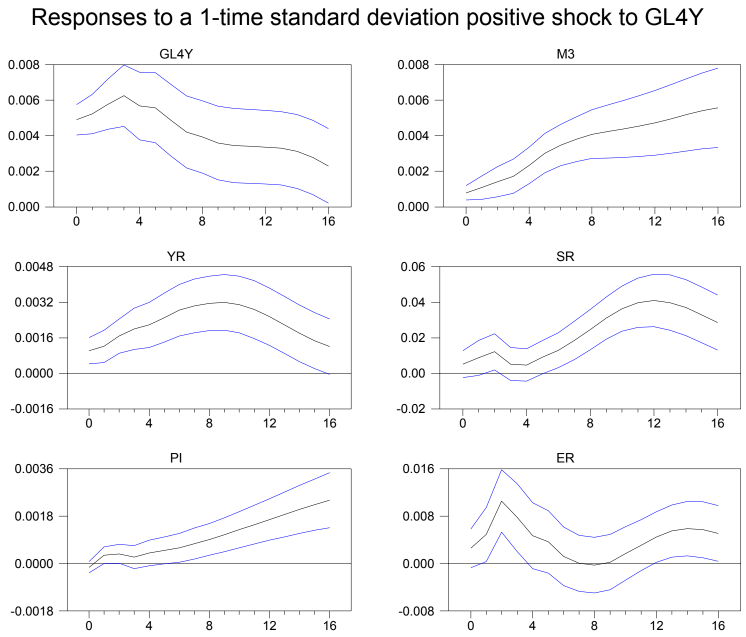

Figure 8: Impulse responses from Model 1a (including 90% confidence bands)

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.[15]

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 forecast error variance decomposition of M3, prices and real GDP. 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 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.

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

[15] 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.

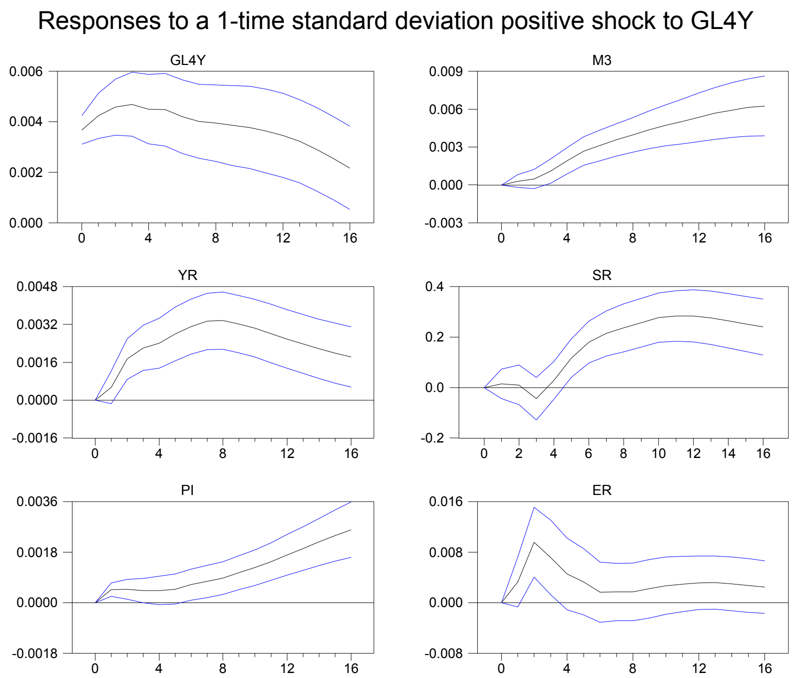

Figure 9: Impulse responses from Model 2a (including 90% confidence bands)

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.

Table 2. Forecast error variance 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

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.[16]

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.

6 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

[16] 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.

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 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 economic policy management of a country. The evidence reported suggests 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 of different sources of investment, 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.

A Data annex

The Table below provides an overview of the series used in this study. All series are seasonally adjusted except interest rates and the real effective exchange rate of the euro.

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 monetary 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.

Variable	Definition	Sources
Broad monetary aggregates	Euro area: M3	ECB.
	US: M2	US Federal Reserve Board (press release H6)
	Japan: M2 plus certificates of deposit	Bank of Japan
	UK: M4	Bank of England
	Canada: M2+	Bank of Canada
Real GDP, GDP deflator and CPI	Euro area (HICP)	Eurostat
	US	OECD Main Econ. indicators
	Japan	OECD Main Econ. indicators
	Canada	OECD Main Econ. indicators
	UK	OECD Main Econ. indicators
Short-term interest rates	Euro area: three-month interbank rate (until 29 December 1998); three-month EURIBOR (thereafter)	ECB
	US	OECD Main Econ. indicators
	Japan	OECD Main Econ. indicators
	Canada	OECD Main Econ. indicators
	UK	OECD Main Econ. indicators
Total commodity prices	Commodity Price Index	HWWA
Real (CPI-based) effective exchange rate of the euro	Aggregation of the bilateral exchange rate of the euro against 12 partner countries.	ECB

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:

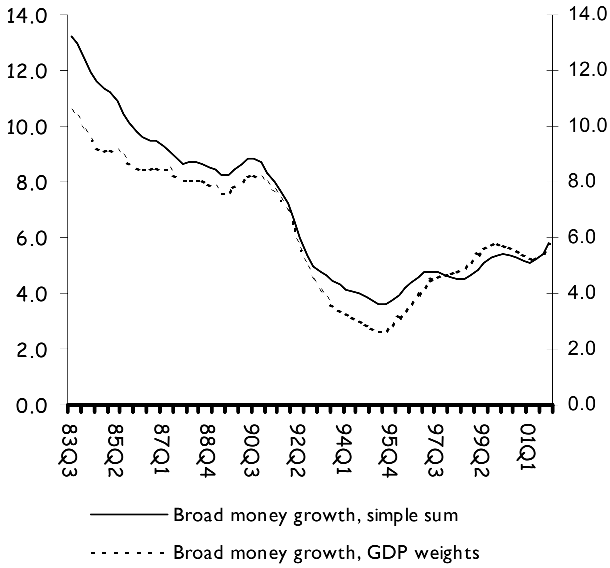

Figure 10: Global liquidity computed with different weights

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

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 10 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.

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