

Global Monetary Policy Shocks in the G5: a SVAR Approach

Joao Miguel Sousa¹ and Andrea Zaghini²

Abstract

The paper constructs a global monetary aggregate, namely the sum of the key monetary aggregates of the G5 economies (US, Euro area, Japan, UK, and Canada), and analyses its indicator properties for global output and inflation. Using a structural VAR approach we find that after a monetary policy shock output declines temporarily, with the downward effect reaching a peak within the second year, and the global monetary aggregate drops significantly. In addition, the price level rises permanently in response to a positive shock to the global liquidity aggregate. The similarity of our results with those found in country studies might support the use of a global monetary aggregate as a summary measure of worldwide monetary trends.

JEL classification: E52, F01.

Keywords: Monetary policy, Structural VAR, Global economy.

* We are grateful to Alessandro Calza, Michael Ehrmann, Leonardo Gambacorta, Livio Stracca and to participants the XII International Tor Vergata Conference on Banking and Finance and the XIX European Economic Association Congress. This paper does not necessarily reflect the views of the Banco de Portugal and of the Banca d'Italia.

1 Banco de Portugal (Joao.Miguel.Sousa@bportugal.pt)

2 Banca d'Italia (andrea.zaghini@bancaditalia.it)

1. Introduction

Over recent years, monetary trends in the major industrialized countries have exhibited many similarities. Moreover, several commentaries suggest that global liquidity significantly affects financial conditions in international markets and that liquidity developments in one financial center can influence financial conditions elsewhere. However, 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 behavior of global macroeconomic and financial variables. After the early attempt by McKinnon (1982), in which the author studied the effects of changes in the “world money supply” on US price inflation, only recently sound econometric works emerged on the issue of cross-country monetary spillovers (Baks and Kramer, 1999; Kim, 2001; Holman and Neumann, 2002; Canova, 2005). This paper follows this recent strand of research and goes a step further by studying the effects of shocks to global money on global inflation and output.

The analysis is based on an aggregated model of the most industrialized countries. The basic idea is to use global (G5) monetary aggregates in order to pool information from several countries to assess to what extent stylized facts in closed economies can be extended to a broader global model. In fact, such global aggregates are likely to internalize cross-country movements in monetary aggregates (due to capital flows between the different regions) that may make the link between money and inflation and output more difficult to disentangle in the single country case.

A further motivation of this paper is to investigate to what extent a global monetary aggregate can be useful for analyzing international liquidity conditions. Several institutions (ECB, IMF, OECD) have used global aggregates as summary measures of the worldwide monetary situation. Since we think that such use deserves a rigorous test of the information content of global monetary indicators, we propose in this paper an econometric analysis

based on the structural VAR approach. In fact, a mere correlation between global money and global inflation and/or output is not sufficient to determine the direction of the relationship between the variables given that they are all endogenously determined. In this regard, the structural VAR approach is a more powerful methodology to investigate this link, as it controls for the interactions between the variables allowing us to provide a more appropriate assessment of the contribution of monetary shocks to global output and inflation.

The paper is organized as follows: Section 2 provides some information and stylized facts about global liquidity and its relationship with other aggregated variables, Section 3 presents the empirical framework of the SVAR analysis. In Section 4 we introduce our global model with aggregate variables for the group of the G5 countries. In Section 5 we perform a robustness check while Section 6 concludes.

2. Preliminary evidence on global liquidity

The global liquidity aggregate analyzed in this paper is constructed as a sum of the reference monetary aggregates for 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).¹

In order to get some insights into the series underlying the global liquidity aggregate, Figure 1 plots the annual growth rate of broad monetary aggregates in different countries in domestic currency. As can be seen in the chart, although money growth rates in the different areas seem to be only weakly correlated in the short-run, in longer periods there appears to be clear co-movements. In particular, the 1980s are characterized by higher monetary growth almost everywhere, while in the 1990s average money growth was lower in all the economies considered. In addition, in the early 1990s there is a clear slowdown in money growth that

¹ The monetary aggregates have been chosen by looking at the most common indicators used in the econometric literature, for each country, when dealing with money demand and supply. See Sims and Zha (1998), Hendry and Mizon (1998), Coenen and Vega (2001), Yamada (2000) and Holman and Neumann (2002), among others.

has occurred at about the same time in most of the countries. Only in the Euro area, such slowdown took place somewhat later, in the years 1994-1995. More recently, there seems to be a similar behavior in money growth internationally, with the rise in monetary growth from the end of 2001 onwards occurring roughly at the same time in most countries. Although country specific factors have played a role, developments in the Euro area, the US and the UK have shared common features. In the US, the strong growth in M2, while partly related to the increased refinancing activity of mortgage loans, also reflected the low level of short-term interest rates and precautionary demand for assets included in M2. In the UK, the strong growth in M4 was related to the strengthening of economic activity but also to precautionary savings and a higher aversion by the public to invest in equity.

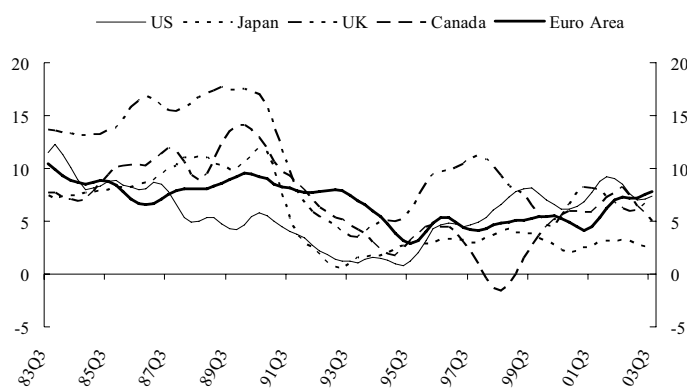


Fig. 1. Four quarter moving average of annual money growth in different economies.

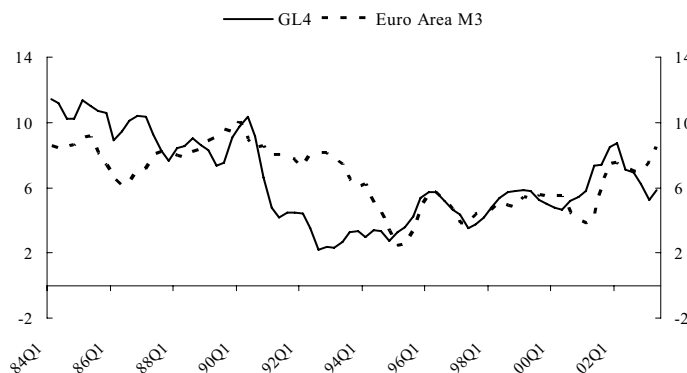


Fig. 2. Non-euro area monetary aggregate at PPP exchange rates (GL4) and euro area M3 (annual growth rates).

For instance, the existence of co-movements between Euro area M3 and broad money in the other four economies becomes clearer if M3 growth is compared to an aggregation of the monetary aggregates of the non-Euro area countries (converted into euro with PPP exchange rates: GL4). This is shown in Figure 2 with the details of the aggregation are reported in the Appendix. From the chart it can be seen that with the exception of a 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.

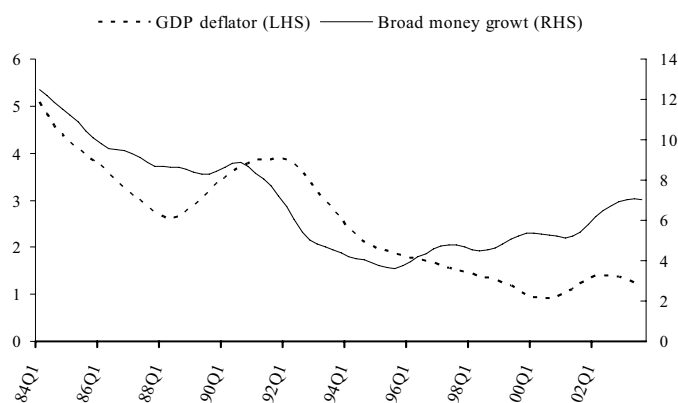


Fig. 3. Global liquidity (GL5) and global inflation (four quarter moving average of annual growth rates).

Figure 3 shows the developments of the annual growth rate of a global liquidity aggregate including all the five economies (GL5) and the global inflation rate (measured by the annual growth rate of the GDP deflator of the countries considered). Even though there are several periods when the developments in the two variables appear not to be strongly related, overall there is a positive correlation between global inflation and global liquidity. The chart also suggests that the decline in the growth of global liquidity preceded the

disinflationary period in the first half of the 1990s. However, 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.

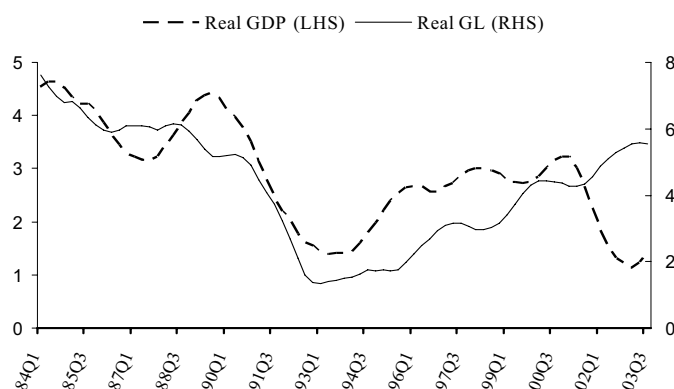


Fig. 4. Four quarter moving average of the annual growth of real global liquidity (GL5R) and real GDP.

The developments in the real global liquidity aggregate and in global real GDP growth are shown in Figure 4. As in the case of inflation, a positive correlation between real global liquidity and economic activity emerges: periods when real GDP growth is relatively high (low) appear to coincide with periods where the growth of real broad global liquidity is also relatively high (low). The main 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. Thus, 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 of economic agents worldwide for holding liquid and safe assets, such as those included in the broad monetary aggregates.

However, as already mentioned in the introduction, the evidence of possible stable relationships among aggregate variables as summarised above deserves a more sound econometric analysis. In particular, it is important to take into account the development of

interest rates worldwide and the evolution of commodities prices to disentangle the possible linkages among global money, output and prices. In the rest of the paper we propose a more accurate empirical framework of analysis in which evaluate these relationships.

3. Empirical framework

There are several advantages in relying on the structural VAR methodology for the analysis of the effects of monetary policy changes. In particular, it allows modelling non-recursive structures of the economy with a parsimonious set of variables and it facilitates the interpretation of the contemporaneous correlations among disturbances.²

Consider the following model as in the traditional reduced-form VAR analysis:

$$\Gamma(L)Y_t = u_t \quad (1)$$

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

$$E(u_t) = 0 \quad (2)$$

$$E(u_t u_s') = \begin{cases} \Sigma & \text{when } t = s \\ 0 & \text{when } t \neq s \end{cases} \quad (3)$$

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, the SVAR approach proposes to start from the “true” structural form model.³

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).

³ Sims (1980) suggested 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.

$$K(L)Y_t = e_t \quad (4)$$

$$K(L) = K + \sum_{i=1}^k A_i L^i$$

where K is an $n \times n$ non singular matrix. The contemporaneous relations are thus directly explained in K . The structural model is linked to the reduced form (1) by:

$$K_i = -K\Gamma_i \quad (5)$$

$$Ku_t = e_t \quad (6)$$

$$E(Ku_t u_t' K') = K\Sigma K' = E(e_t e_t') = I \quad (7)$$

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.⁴

The SVAR methodology suggests to impose restrictions on the contemporaneous structural parameters only, so that reasonable economic structures might be derived.⁵ The fact that only contemporaneous restrictions are imposed however does not imply that there is no feedback among variables. In the (S)VAR structure the lagged values enter each equation and thus all variables are linked together.

4. A global approach

In this section we propose a unified G5 model including aggregated variables from the most industrialized areas (US, Euro area, Japan, UK and Canada). In particular, we try to identify a common monetary policy shock in this enlarged 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

⁴ In the structural form of the generic model of lag-length k there are kn^2+n^2 free parameters belonging to K and K_i , while from the estimates of Γ_i and Σ one gets only $kn^2+n(n+1)/2$ values.

⁵ This specification scheme is 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), Mojon and Peersman (2003), Dedola and Lippi (2005) for other countries.

endogeneity in open-economy single country models. In fact the possible endogeneity from monetary policy shocks derives from a “following the leader” behavior by which a given country (the follower) always adjusts its monetary policy stance accordingly to the decisions of a leader. Thus, a 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 the 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.⁶

As a basis of our analysis of global liquidity shocks in the G5 countries, we need a benchmark model able to properly explain the macroeconomic short- and long-term dynamics of each country under consideration. Our first choice is based on a specification proposed by Kim (1999) for each of the G7 countries and later tested for the Euro area as a whole by Peersman and Smets (2003) and Sousa and Zaghini (2004). However, since the specification estimated in the latter two papers slightly differs from the one in Kim (1999), we propose a given set of restrictions that is, also for the Euro area, as close as possible to the one by Kim (1999). In particular, we will keep the quarterly frequency of the data and four out of five variables as in Peersman and Smets (2003) and Sousa and Zaghini (2004), but, following Kim (1999), we will use a total commodities index converted into domestic currency instead of the effective exchange rate of the euro.

Thus, the vector of endogenous variables is as follows:

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

where $YR5_t$ is the real GDP, $PI5_t$ is the consumer price index, $GL5_t$ is the monetary aggregate and $SR5_t$ is the average short-term interest rate of the G5 area, whereas TC_t is the commodities price index in euro (see data Annex for details).

⁶ See for instance Kim and Roubini (2000) and the discussion in Dornbusch et al. (1998).

The identification scheme used is characterized by the following non-recursive structure of the kind $Ku_t = e_t$:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ k_{21} & 1 & 0 & 0 & 0 \\ k_{31} & k_{32} & 1 & k_{34} & 0 \\ 0 & 0 & k_{43} & 1 & k_{45} \\ k_{51} & k_{52} & k_{53} & k_{54} & 1 \end{bmatrix} \begin{bmatrix} u_t^{YR5} \\ u_t^{PI5} \\ u_t^{GL5} \\ u_t^{SR5} \\ u_t^{TC} \end{bmatrix} = \begin{bmatrix} e_t^{YR5} \\ e_t^{PI5} \\ e_t^{GL5} \\ e_t^{SR5} \\ e_t^{TC} \end{bmatrix} \quad (8)$$

The first two equations deal with the non-policy variables with GDP and prices responding to financial innovations (money, interest rate and commodities price) only with a lag. The third and fourth equations include the global liquidity aggregate and the contemporaneous central bank reaction functions. The global liquidity aggregate is assumed to react in the same quarter to shocks on real income, the price index and the short-term interest rate, while the monetary authority feedback rule relates the interest rate to contemporaneous changes in the monetary aggregate and the commodities price. As in Sims and Zha (1998), the choice of this monetary policy reaction function 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. More in details: published data on money and the exchange rate are available within the period but reliable data on output and prices are not. In the fifth equation the total commodities index reacts to contemporaneous changes in all the other variables. However, concerning the money supply equation in particular, the basic idea underlying the SVAR approach is that not all changes in the monetary policy stance reflect a systematic response to variations in the state of the economy: the unaccounted alteration is referred to as a monetary policy shock. This shock can be interpreted as a deviation of the interest rate from the monetary policy rule that the central bank is assumed to be following.⁷

Estimations are based on quarterly data over the period from 1980 Q1 to 2001 Q4. Data are expressed in logarithmic form and are seasonally adjusted, except the interest rates which

⁷ See Christiano, Eichenbaum and Evans (1998) for possible explanations on this point.

are in levels. A constant and a linear trend are added to the model. Standard information tests hinted to a 4-lag length for the VAR.⁸

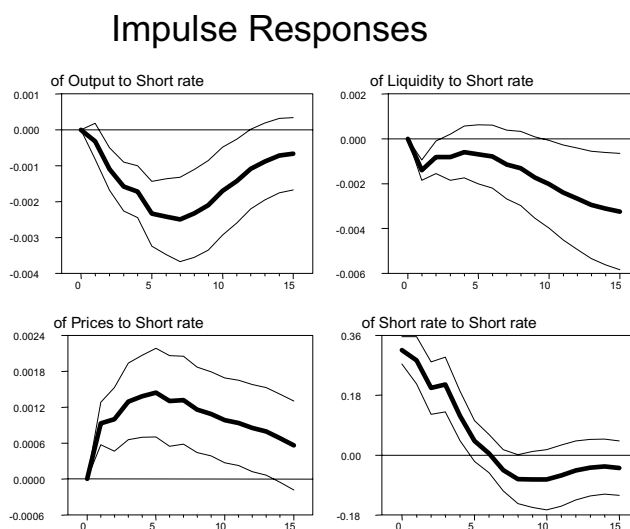


Fig.5. Monetary Policy Shock.

Figure 5 depicts the impulse response functions to an unexpected monetary policy shock. We can see that, as in a single country model, 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 figure highlights a clear “price puzzle”: for 2 years prices increase and only thereafter start to decline. One possible explanation of the price puzzle that is usually found in VAR studies is the omission of a variable useful in forecasting inflation (such as the commodity price index) which implies that endogenous responses to expected inflation increases will mistakenly be taken as monetary policy shocks (see Giordani, 2004).

In the case of our model, the absence of an exchange rate term in the specification may result problematic, since we take the G5 economies as our world economy but the currencies of omitted countries may still play a relevant role for G5 inflation trends. In addition, G5

⁸ In particular, the LR test, the Akaike information criterion and the FPE test pointed to a 4-lag length, while the Schwarz and HQ criteria suggested a smaller number of lags.

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 the domestic currency and which may differ from country to country. Finally, it could be the case that, as suggested by Giordani (2004), one should use the output gap instead of the level of real output in the VAR, as that might solve the price puzzle.

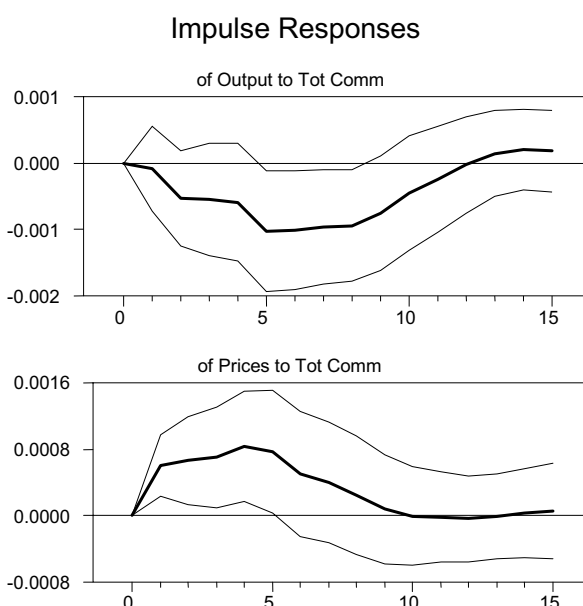


Fig.6. Total Commodity Index Shock.

Figure 6 shows the impulse responses of output and prices to a shock to the total commodity index. As seen in the chart, an exogenous increase in commodity prices temporarily decreases global output. This effect is only significant after a year and a half after the shock. In the long-run, output returns to the initial level. As for prices, the reaction of the price level appears to be immediate, with an increase one quarter after the shock. As with real GDP, the effect on global prices peaks after five quarters after which the price level gradually returns to the initial level.

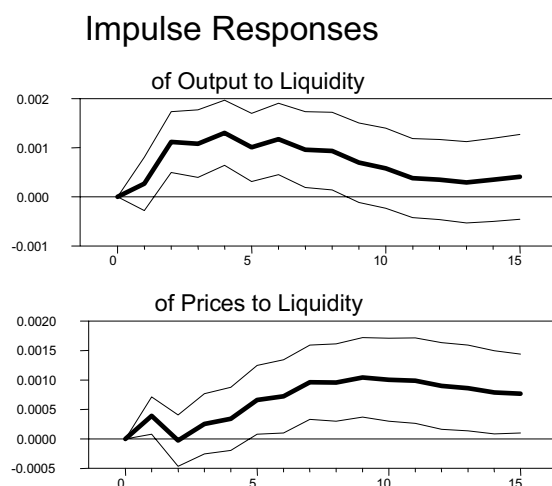


Fig. 7. Global Liquidity Shock.

The reactions of real GDP and prices to a shock in the global liquidity are reported in Figure 7. Given that we rely on broad measures of the monetary aggregate, we interpret our global liquidity shocks as a money demand shock, namely an exogenous increase in agents' preferences for liquidity. As seen in the figure, 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.

We now analyze the results concerning the sources of output and price fluctuations. As for global GDP (Figure 8), 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.

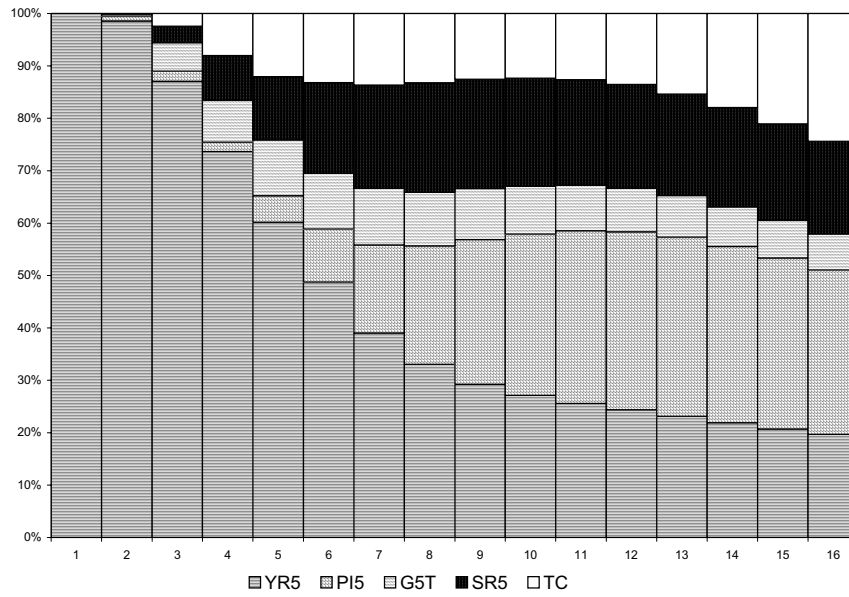


Fig.8. GDP Variance Decomposition.

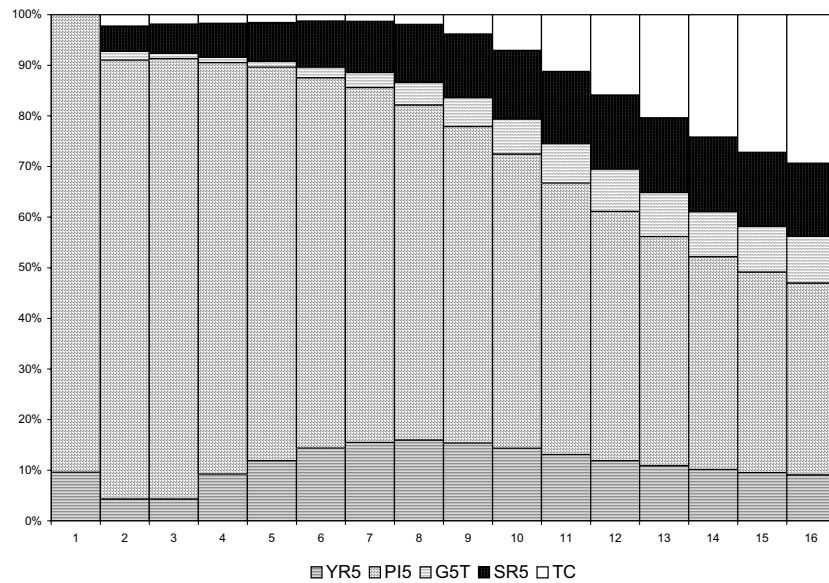


Fig.9. CPI Variance Decomposition.

Figure 9 depicts the contributions to price fluctuations. As one would expect, 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 limited.

5. Robustness

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.

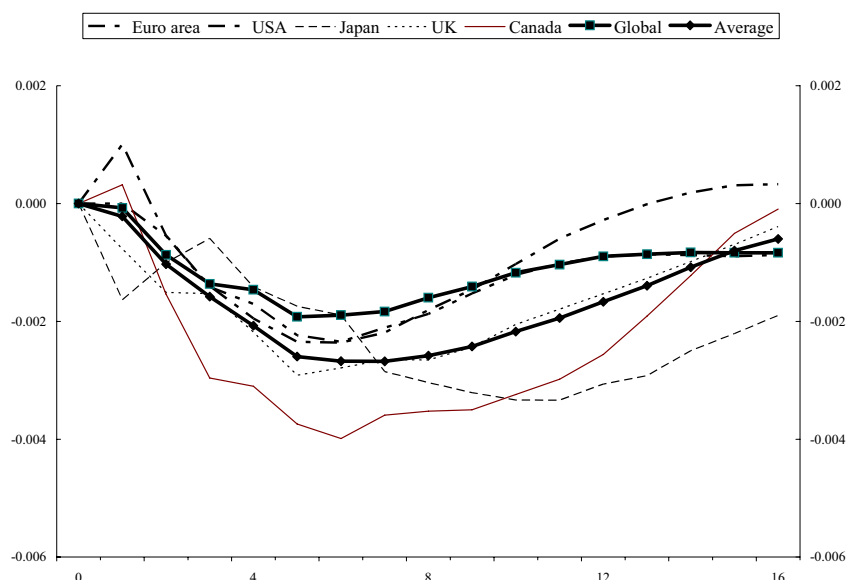


Fig. 10. Impulse responses of real GDP to a monetary policy shock.

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 10 shows the real output response to a positive monetary policy shock (an increase of 1-time the standard

deviation of the short-term interest rate) for the US, the Euro area, Japan, the UK and Canada together with the average cross-country effect and the impulse response stemming from the global framework. The shape of the curve is indeed similar for the whole group of countries and the two “average measures”; only Japan seems to suffer a longer contractionary effect from a tightening of the monetary stance. However, the dynamics seem 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 of the global framework here implemented.

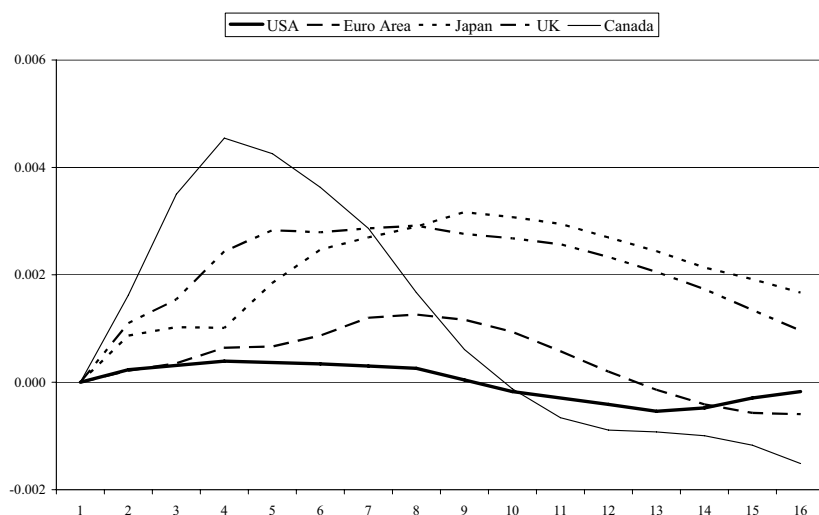


Fig. 11. Impulse responses of real GDP to a liquidity shock.

Since the focus of this study is on the influence of monetary liquidity on other macroeconomic variables, we replicate Figure 7 for each country. In particular, Figure 11 and Figure 12 show the impulse responses of output and prices to a shock in the domestic monetary aggregate, respectively. As for the reaction of real GDP, we can observe that Canada responds in relatively quick fashion to the shock in the domestic liquidity, while the impact for the US seems to be indeed marginal. For the other countries the reactions are in line with what expected and with the global estimate: there is a positive temporary increase, which tends to be reabsorbed within the 4-year horizon.

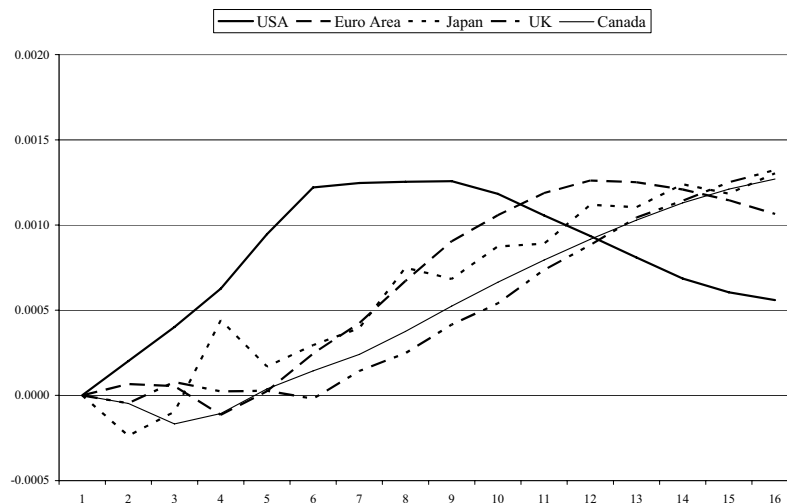


Fig.12. Impulse responses of prices to a liquidity shock.

Also the results stemming from Figure 12 are in line with the economic wisdom. The impact of a liquidity expansion is transmitted to prices only with a lag also at national level. In the US the impact seems to be faster than in the other economies, with a peak reached already in the second year. However, the different speed at which each country adjusts to the liquidity shock and the time-lag necessary to impact on prices dynamics confirm the results of a recent strand of the economic research. Several contributions suggest that the one-to-one relation between money and prices derived from the quantity theory, while being generally valid in the long-run, may not hold over shorter periods of 2 to 3 years (Bachmeier and Swanson, 2005; Bruggeman et al., 2005; Roffia and Zaghini, 2005). This in turn implies that the leading properties of money for inflation may not be strong over a relatively short horizon.⁹

Thus, signals emerging from monetary developments, while maintaining their long-run structural leading properties for prices, have to be supported by other kind of analysis in the short-run, for instance indicators of the business-cycle position of an economy.

⁹ De Grauwe and Polan (2005) suggest instead that the quantity equation relationship may not hold in a framework of very low inflation.

One interesting aspect of the above results is that there is a great deal of similarity in the empirical responses of the macroeconomic variables to liquidity shocks across countries. This seems to suggest that the role of money in the economy tends not to differ markedly across the countries considered. In turn, according to these results, there are no strong reasons for the differences observed in the importance given to monetary aggregates in the monetary policy strategy of major central banks.¹⁰

6. Conclusion

This paper explicitly modelled a global G5 framework relying on a common structural identification scheme that worked well for each single area. The global framework points to a strong similarity in the behavior of aggregate variables compared to single economy 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, when analyzing the impact of an unexpected change in the G5 monetary aggregate on GDP and inflation, the results are as one would expect from the corresponding responses in a single economy. In fact, the global price level rises permanently and real global output only temporarily in response to a positive shock to global liquidity. Also as far as volatility is concerned, the results of the decomposition of the forecast error variance show that global real output and price fluctuations can be explained in the aggregated framework in the same vein as in single country model.

The overall similarity in the results in the aggregated G5 framework relative to single country models suggests that a global liquidity measure might be used, together with traditional cross-country variables, as an indicator of global monetary conditions in about the same way the domestic monetary aggregates are used in the single economy case.

¹⁰ For instance, monetary aggregates are given a prominent role in the monetary policy strategy of the ECB while they rarely play a role in the monetary policy of the US Federal Reserve.

As further extensions of this work, it would be useful to perform a thorough analysis of the leading indicator properties of global liquidity for prices and economic activity taking into account also the forecast horizon. At the same time another possible extension would be to study the joint developments in global assets price and global liquidity possibly in a larger group of countries including also emerging market economies.

Appendix

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. These aggregates have been chosen as they 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 each country against the euro as the basis. 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 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 aggregates used to construct it. As there may be problems of comparability between the aggregates used for the different countries, 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 some 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 A.1 shows the difference between the two series. As can be seen in the chart, most of the time differences are limited.

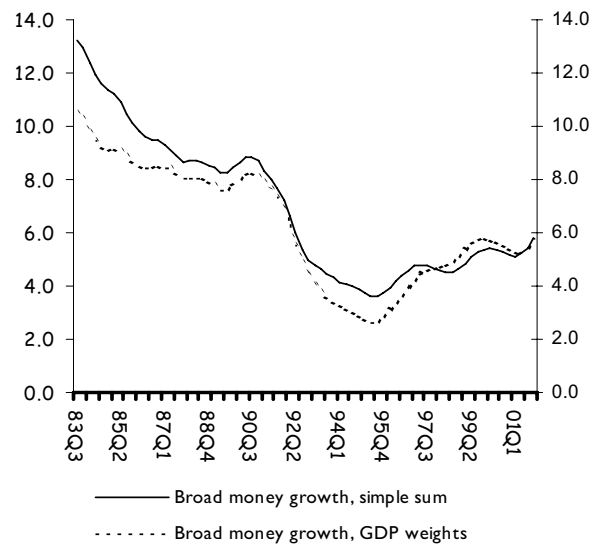


Fig. A.1. Global liquidity computed with different weights.

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 making recourse to GDP weights obtained using PPP exchange rates to convert each national nominal GDP into euro. Table A1 provides an overview of the series used in this study. All series are seasonally adjusted except interest rates.

Table A1

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

References

- Amisano, G., Giannini, C., 1997. Topics in structural VAR econometrics. Springer, Heidelberg and New York.
- Bachmeier, L.J., Swanson, N.R., 2005. Predicting inflation: does the quantity theory help? *Economic Inquiry* 11, 570-585.
- Baks, K., Kramer, C., 1999. Global liquidity and asset prices: measurement, implications and spillovers. International Monetary Fund. Working Paper 1999/168.
- Bruggeman, A., Camba-Méndez, G., Fischer, B., Sousa, J., 2005. Structural filters for monetary analysis. European Central Bank. Working Paper 470.
- Canova, F., 2005. The transmission of US shocks to Latin America. *Journal of Applied Econometrics* 20, 229-251.
- Christiano, L., Eichenbaum, M., Evans, C., 1999. Monetary policy shocks: what have we learned and to what end? In: Taylor, J., Woodford, M. (Eds.), *Handbook of Macroeconomics*, North Holland, Amsterdam.
- Coenen, G., Vega, J.L., 2001. The demand for M3 in the Euro Area. *Journal of Applied Econometrics* 16, 727--748.
- De Grauwe, P., Polan, M., 2005. Is inflation always and everywhere a monetary phenomenon? *Scandinavian Journal of Economics* 107, 239-260.
- Dedola, L., Lippi, F., 2005. The monetary transmission mechanism: evidence from the industries of five OECD countries. *European Economic Review* 49, 1543-1570.
- Dornbusch, R., Favero, C., Giavazzi, F., 1998. The immediate challenge for the European Central Bank. *Economic Policy* 13, 15-64.
- Giordani, P., 2004. An alternative explanation of the price puzzle. *Journal of Monetary Economics* 51, 1271-1296.
- Gordon, D.B., Leeper, E.M., 1994. The dynamic impacts of monetary policy: an exercise in tentative identification. *Journal of Political Economy* 102, 1228-1247.
- Grilli, V., Roubini, N., 1995. Liquidity and exchange rates: puzzling evidence from the G7 countries. Salomon Center, New York University. Working Paper 31.
- Hendry, D.F., Mizon, G.E., 1998. Exogeneity, causality, and co-breaking in economic policy analysis of a small econometric model of money in the UK. *Empirical Economics* 23, 267-294.
- Holman, J.A., Neumann, R.M., 2002. Evidence on the cross-country transmission of monetary shocks. *Applied Economics* 34, 1837-1857.
- Kim, S., 1999. Do monetary policy shocks matter in the G-7 countries? Using common identifying assumptions about monetary policy across countries. *Journal of International Economics* 48, 387-412.
- Kim, S., 2001. International transmission of US monetary policy shocks: evidence from VARs. *Journal of Monetary Economics* 48, 339-372.
- Kim, S., Roubini, N., 2000. Exchange rate anomalies in the industrial countries: a solution with a structural VAR approach. *Journal of Monetary Economics* 45, 561-586.

- Leeper, E.M., Roush, J.E., 2003. Putting 'M' back in monetary policy. *Journal of Money, Credit, and Banking* 35, 1217-1256.
- McKinnon, R.I., 1982. Currency substitution and instability in the world dollar standard. *American Economic Review* 72, 320-333.
- Mojon, B., Peersman, G., 2003. A VAR description of the effects of monetary policy in the individual countries of the Euro Area. In: Angeloni, I., Kashyap, A., Mojon, B. (Eds.), *Monetary policy transmission in the Euro Area*, Cambridge University Press, Cambridge.
- Peersman, G., Smets, F., 2003. The monetary transmission mechanism in the Euro Area: more evidence from VAR analysis. In: Angeloni, I., Kashyap, A., Mojon, B. (Eds.), *Monetary policy transmission in the Euro Area*, Cambridge University Press, Cambridge.
- Pesaran, M.H., Smith, R., 1995. Estimating long-run relationship from dynamic heterogeneous panels. *Journal of Econometrics* 68, 79-113.
- Roffia, B., Zaghini, A., 2005. Excess money growth and inflation dynamics. European Central Bank and Bank of Italy (manuscript).
- Sims, C.A., 1980. Macroeconomics and reality. *Econometrica* 48, 1-48.
- Sims, C.A., Zha, T.A., 1998. Does monetary policy generate recessions? Working Paper 12, Federal Reserve Bank of Atlanta.
- Sousa, J., Zaghini, A., 2004. Monetary policy shocks in the Euro Area and global liquidity spillovers. European Central Bank. Working Paper 309.
- Yamada, H., 2000. M2 demand relation and effective exchange rate in Japan. *Applied Economic Letters* 7, 229-232.