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Ansgar Belke and Walter Orth

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A VAR Analysis for OECD Countries

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Ansgar Belke and Walter Orth*

Global Excess Liquidity and House Prices – A VAR Analysis for OECD Countries

Abstract

The belief that house prices are driven by specific regional and institutional variables and not at all by monetary conditions is so entrenched with some market participants and some commentators that the search for empirical support would seem to be a trivial task. However, this is not the case. This paper investigates the relationship between global excess liquidity and asset prices on a global scale: How important is global liquidity? How are asset (especially house) prices and other important macro variables like consumer prices affected by global monetary conditions? This paper analyses the international transmission of monetary shocks with a special focus on the effects of a global monetary aggregate ("global liquidity") on consumer prices and different asset prices. We estimate a variety of VAR models for the global economy using aggregated data that represent the major OECD countries. The impulse responses show that a positive shock to global liquidity leads to permanent increases in the global GDP deflator and in the global house price index, while the latter reaction is even more distinctive. Moreover, we find that there are subsequent spillovers to consumer prices. In contrast, we are not able to find empirical evidence in favour of the hypothesis that the MSCI World index as a measure of stock prices significantly reacts to changes in global liquidity.

JEL Classification: E31, E52, F01, F42

Keywords: Global liquidity, inflation control, international spillovers, asset prices, VAR analysis

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1 Introduction

The quite expansionary monetary policy of the G3 countries (Euro area, US and Japan) in combination with foreign exchange interventions by many Asian countries – especially China with its dollar reserves now standing at 1.5 billion – has during the last years contributed to a significant increase of global money balances. At the same time, housing prices in large parts of the OECD have increased in parallel. Notable exceptions are Japan where house prices stopped their 15-year fall not earlier than in 2007 and Germany. But it is important to note that house prices generally seem to move in long-term cycles and the respective time series are much smoother than stock markets (Goodhart and Hofmann, 2007, Gros, 2007). Moreover, the increase in the number of mergers and acquisitions and of private equity activities are discussed in the public joint with global liquidity.

In this paper we will address these issues more deeply and investigate the extent and some specific macroeconomic impacts of global liquidity. We come up with the conclusion that the ample liquidity of the Western world has - with an eye on the current debate about the subprime crisis quite surprisingly - contributed to a lesser extent to the recent rallye on stock and bond markets than to an increase of house prices.

Hence, we investigate the existence of a global money market in order to identify potential excess liquidity and analyse its interactions with global inflation and asset prices, as suggested by a number of authors, see Baks and Kramer (1999), Sousa and Zaghini (2006) and Rüffer and Stracca (2006). For this purpose, we estimate a global VAR model including a measure of global liquidity, proxied by a broad monetary aggregate in the OECD countries under consideration (United States, Euro area, Japan, United Kingdom, Canada, Korea, Australia, Switzerland, Sweden, Norway and Denmark), in order to identify the impact of a shock to excess liquidity on output and prices at the level of the world economy. In a further step of the analysis we extend the global VAR model by including a variable measuring house price developments for the same sample of countries. Our analysis has to take into account the above-mentioned observation that housing prices generally seem to move in long-term cycles and are much smoother than stock prices.

In particular, we analyse the impact of a shock to global excess liquidity on a number of macroeconomic variables. In this way, we are able to isolate the impact of a shock to global excess liquidity that is arguably purely monetary in nature, after controlling for the influence of other global variables, notably output and the price level.

The remainder of this paper applies a global VAR analysis to validate the hypothesis that *global monetary conditions systematically drive house prices.* This hypothesis can also be put as a question: Does the probability of house price moves increase after central banks have changed interest rates and, thus, their money supply? In other words, we check whether our expectations formulated in chapter 3 can be backed up by a careful statistical analysis of the data. We proceed as follows: we first examine in chapter 2 some relationships with the existing literature and proceed with some theoretical considerations in chapter 3. In chapter 4 we turn to a more detailed econometric analysis using the VAR technique on a global scale. To ensure robustness we use different lag lengths, a variety of identification schemes and we add further variables like a commodity price index. Chapter 5 concludes.

2 Overview of the literature

The concept of "global excess liquidity" has attracted considerable attention in recent years, although the empirical literature regarding this topic is still quite scarce. Only a few other studies apply a research strategy to estimate a global VAR model which is similar to the one conducted in this paper. Our first reference study is Rüffer and Stracca (2006). They estimate a VAR model with aggregated G5 data using the same macroeconomic variables as used here in the benchmark specification. They identify and address the "price puzzle", i.e. the initial increase of prices as a reaction to a more restrictive monetary policy, and cannot solve it by applying a commodity price index either. They also augment their model with a real asset price index that incorporates property and equity prices. The main difference to our paper is their finding that the response of the price level to a global liquidity shock is even more distinctive, while the real asset price index does not show any significant reaction to global liquidity.

Our second reference study is Sousa and Zaghini (2006). They also estimate a SVAR model for the G5 with aggregated data. Moreover, they include a commodity price index for their whole analysis and deviate from the standard Cholesky identification scheme in restricting the structural equations. The so-called price puzzle is not solved by the commodity price index in this study, too. Sousa and Zaghini also find a significant and long-lasting response of the price level to a global liquidity shock. One caveat with respect to a sound interpretation of their findings may be that their sample period for estimation ends already in 2001. It is by now well-known that in the post-2001 period the relationship between money and prices was less stable than before - a finding which might challenge the stability of their results.

The paper which might be conceptually closest to ours is Greiber (2007). He also uses standard VAR techniques for G5 data and estimates a benchmark specification which is augmented in the subsequent analysis with house prices, stock and commodity prices. The response of the price level to a global liquidity impulse is significantly in the expected direction and is also very persistent. This piece of evidence might serve as an additional empirical corroboration of the inflationary pressures exerted by global money in the long run. The results with respect to the inclusion of the asset price variables are very similar to our own results. The empirical realisations of the house price index display a significant appreciation in the wake of loose monetary conditions, namely to money and interest rates. As reverse causation is concerned, the linkage between house prices and liquidity works as well, since a house price shock in the study by Greiber significantly contributes to a rise in money holdings. Like in our analysis, there are no substantial effects regarding stock prices, as measured through the MSCI World index, delivered by Morgan Stanley, the commodity price index and the oil price.

A prominent role for housing prices among other specific kinds of asset prices in the same context is also found at a global scale by Giese and Tuxen (2007). These authors find significant cointegration relationships which indicate a positive impact of global liquidity on house prices and more general inflation. However, their study is still in progress and so we might be cautious with an interpretation of these results.

In this paper, we focus on a *global model*. However, we do not explicitly deal with spillovers to *national variables*. We feel legitimised to do so because - according to recent research - inflation appears to be a global phenomenon. For instance, Ciccarelli and Mojon (2005) cannot empirically reject the existence of an error-correction mechanism between national and global inflation. Hence, one can conclude that deviations from the global inflation trend are not sustainable in the long run. In addition, we would like to refer also to Borio and Filardo (2007) who show that a more globe-centric approach to inflation is by far more adequate, because global factors have become increasingly relevant for empirical realisations of national inflation rates.

As it was just said, the focus of our paper is clearly on the *global perspective*. However, given recent findings that inflation might be an increasingly global phenomenon, the potential threats for future price stability which can be derived from the evidence of this paper and the related literature seem to be also *relevant on a country level*. Note also, that several country-level studies that include asset prices find empirical evidence in a similar direction.[1] These studies basically support in some way one of the major findings of our paper, namely that global liquidity fuels house price inflation and that there might be subsequent spillovers to consumer prices.

Finally, we would like to address one of the most recent country-level studies in this field, namely Roffia and Zaghini (2007). Using probit regressions for 15 countries, they find evidence in favour of the hypothesis that periods of strong monetary growth are likely to turn into periods of high inflation, especially if they are accompanied by asset price inflation. Given the fact that both conditions fit quite well to the situation observed on the world financial markets at least until spring 2007, this scenario has most probably contributed to the more recent positive trend of inflation rates observed in the second half of 2007 for instance in the Euro

[1] See Goodhart and Hofmann (2000), Greiber and Setzer (2007), Adalid and Detken (2007), Congdon (2005) or Roffia and Zaghini (2007).

area.

3 Theoretical considerations

3.1 The global perspective

If one considers the development of global liquidity over time, the question is often raised whether and to what extent global factors can be made responsible for it. Rüffer and Stracca (2006) investigate this important aspect for the G7 countries in the framework of a factor analysis and conclude that around fifty percent of the variance of a narrow monetary aggregate can be traced back to one common global factor. As one prominent example of such a global factor for instance the extremely lax monetary policy stance of the Bank of Japan (BoJ) during the last years should be mentioned here. It has been characterised by a significant accumulation of foreign reserves and by extremely low interest rates - at some time even approaching zero. By means of carry trades, financial investors took out loans in Japan which they invested in currencies with higher interest rates. In our context, it is important to note that such kind of capital transactions of course also have an impact on the development of monetary aggregates beyond Japan. In addition, we would like to argue that national monetary aggregates have become more difficult to interpret due to the huge increase of international capital flows (Papademos, 2007).

Exactly this problem of increasing difficulties of interpreting national monetary aggregates properly is also addressed by some other authors. Sousa and Zaghini (2006) argue that 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. Moreover, Giese and Tuxen (2007) stress the fact that shifts in the money supply in any one country may be absorbed by demand elsewhere in today's linked financial markets, but simultaneous shifts in major economies may have significant effects on worldwide goods price inflation.

Not only with respect to global liquidity but also with an eye on global inflation performance, available evidence becomes increasingly stronger that the global instead of the national perspective is more important when monetary transmission mechanisms have to be identified and interpreted. For instance, Ciccarelli und Mojon (2005) apply a factor analysis to macroeconomic data of 22 OECD countries and establish that seventy percent of the variance of the inflation rates of these countries can be traced back to a common factor. Moreover, the same authors find empirical evidence in favour of a robust error-correction mechanism, meaning that deviations of national inflation from global inflation are corrected over time. They conclude that national inflation is to a large degree a global phenomenon.

Borio and Filardo (2007) deliver a similar result. Referring to their empirical results, they argue that (a) the traditional way of modeling inflation is too country-centered, (b) a global approach is more adequate and that (c) the importance of global factors has increased significantly more recently. One important global factor, for instance, is certainly represented by the mounting pressure enacted by the ever higher degree of competition on the international goods and labour markets - a phenomenon which has to be mainly ascribed to globalisation. It appears fair to say that the globalisation process has contributed to the decrease of inflation rates since the eighties (and that this puts the contribution of central banks on the agenda again).[2] It goes without saying that we do not take the view that the national perspective is completely negligible. Instead, we emphasize in our paper that a global model, as estimated in the econometric section of our paper, may deliver additional relevant insights which certainly cannot be gathered if one concentrates solely on the national level and neglects global liquidity developments.

3.2 Monetary policy and house prices

While there is some literature available on the impact of house price developments on the macroeconomy[3] and on the role of fundamental factors other than monetary policy for house price developments (Catte et al., 2004, Égert and Mihaljek, 2007),

[2] Vgl. Rogoff (2003).

[3] Monetary policy driven rising house prices may drive consumer spending and thus, aggregate demand and inflation via balance sheet and credit-channel effects – more potential collateral meaning lower risk premia in this context via the Bernanke/Gertler financial accelerator framework. According to Gros (2007), the most direct link between housing prices and domestic demand might be construction activity and in particular the construction of houses (dwellings).

studies specifically dealing with the impacts of monetary policy on house prices are still quite scarce. For instance, Goodhart and Hofmann (2007) show that one could use a baseline New Keynesian model as a theoretical benchmark, consisting of a Phillips curve to describe the supply side of the economy and an IS curve to describe the demand side. From a monetary policy perspective, the central parameters are the strength and the significance of the links in the monetary transmission process and the relative importance of backward-looking and forward-looking expectations in the Phillips and the IS curve. As is well-known by now, the empirical literature has delivered diverse and highly controversial results on both issues. Hence, in an extended specification, Goodhart and Hofmann include property prices in the case of the IS curve and show that this restores an empirically significant monetary transmission mechanism.

Mishkin (2007) stresses the user cost of capital as an important determinant of the demand for residential capital. In this context, lower interest rates in the wake of higher money growth should influence mortgage rates and raise the demand for housing capital by decreasing the user cost of capital. However, Mishkin focuses on the effects of interest changes on house price changes and does not explicitly refer to monetary aggregates. He finds empirical evidence in favour of a stable relation between an interest rate shock and house price developments via the FRB/US model.

A more general strand of literature investigates the impact of monetary policy on more generally defined asset price developments. One example is Congdon (2005) who investigates the relationship between money supply (specified as broad money) and asset price booms and finds empirical evidence in many cases. For instance, he analyses the portfolio management of (other) financial institutions like pension funds. There, he finds evidence in favour of a long-run stability of the money/asset ratio (percentage of money in their portfolios) and argues – similar to Meltzer (1995) – that increases in the money supply leads to "too much money chasing too few assets" meaning that asset prices rise in order to restore the money/asset ratio.

4 Empirical analysis

4.1 Data description and aggregation issues

In our analysis, we use quarterly time series from 1984Q1 to 2006Q4 for the United States (US), the Euro area, Japan, United Kingdom (UK), Korea, Australia, Switzerland, Sweden, Norway and Denmark, so that our analysis covers 72,2% of the world GDP in 2006 and presumably a considerably larger share of global financial markets.[4] For the aforementioned countries, we gather real GDP (Y), the GDP deflator (P), a short term money market rate (IS), a broad monetary aggregate (M), and, as asset prices, a house price index (HPI) and the MSCI World price index (MSW). The monetary aggregate is M2 for the US, M3 for the Euro Area, M2 plus cash deposits for Japan, M4 for the UK and mostly M3 for the other countries. The data stem from the IMF, the BIS the ECB and the OECD are collected seasonally adjusted where available and otherwise applied to the X12-ARIMA procedure.[5]

In the next step, we aggregate the country series to obtain global series considering the principles mentioned by Beyer, Doornik and Hendry (2000) and employing the same method as used by Giese and Tuxen (2007) in the same context. First, we calculate variable weights for each country by using PPP exchange rates to convert nominal GDP into a single currency.[6] The weight of a country i in period t is therefore:

$$w_{i,t} = \frac{BIP_{i,t}\, e_{PPP\,i,t}}{BIP_{agg,t}}$$

Secondly, we take the growth rates of the variable in domestic currency and aggregate these to global growth rates by using the weights calculated above:

$$g_{agg,t} = \sum_{i=1}^{11} w_{i,t} * g_{i,t}$$

Aggregate levels can now be obtained by choosing an initial value (e.g. 100) and

[4] Own calculations based on IMF data.

[5] For the delivery of the house price data, we would like to thank Mark Weth and Sebastian Schich from the Deutsche Bundesbank who collected house price data in their project to "'demographic changes and real house prices"'.

[6] 1999 is our base year for the PPP exchange rates.

multiplying with the global growth rates. Hence, the level of the variable v is:

$$index_{v,T} = 100 * \prod_{t=2}^{T} (1 + g_{agg,t})$$

This method is applied to all variables except for the MSCI World, which already represents shares on a global level. Moreover, for the interest rate variable, aggregation is performed directly without calculating growth rates.

Regarding the monetary aggregate which plays a central role in our analysis this method lowers the bias resulting from different national definitions of broad money which obviously exist. Building a simple sum of national monetary aggregates – a method frequently applied in the related literature – would underrepresent countries with narrower definitions of the monetary aggregate and vice versa. A second problem that is avoided is the "dollar bias" resulting from converting national monetary aggregates with actual exchange rates into USD and building a simple sum to obtain global money. In this case the fall of the dollar contributes to an overestimation of global monetary growth.[7]

To illustrate the development of global liquidity since 1984, Figure 1 shows global monetary aggregates in absolute and relative terms. For nominal and real money, a simple regression on an intercept and a linear time trend is performed. Both series are above their time trend since about 2001 when the rapid downturn in stock markets caused households and investors to increase the share of safe assets like money in their portfolios. Monetary growth remained strong afterwards, which can be seen in the persistent growth of the ratio of nominal money to nominal GDP, a measure commonly used as an indicator of excess liquidity.[8] As this series is equal to the inverse of the income velocity of money, it seems obvious that global velocity is not trend-stationary, a phenomenon which has appeared on a country level as well and has contributed to the instability of national money demand equations. Overall, the series confirm our prior that global liquidity is indeed at a high level and that the term excess liquidity ought to be justified.

Figure 2 shows the whole array of our global time series. The price level series

[7] See Commerzbank Economic & Commodity Research (2007), p. 3.

[8] See *inter alia* Belke et al. (2004) or Rüffer and Stracca (2006).

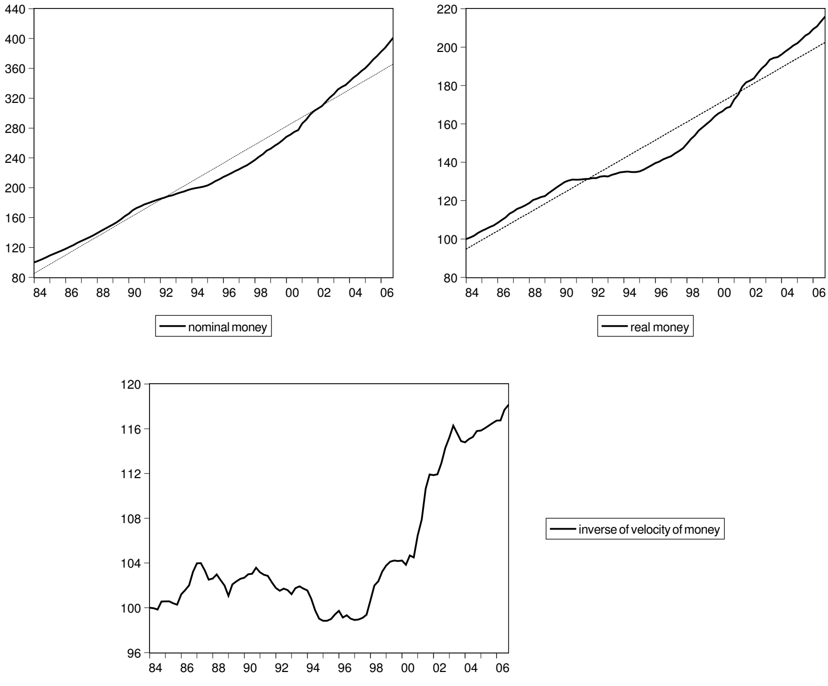

Figure 1: Development in global liquidity since 1984

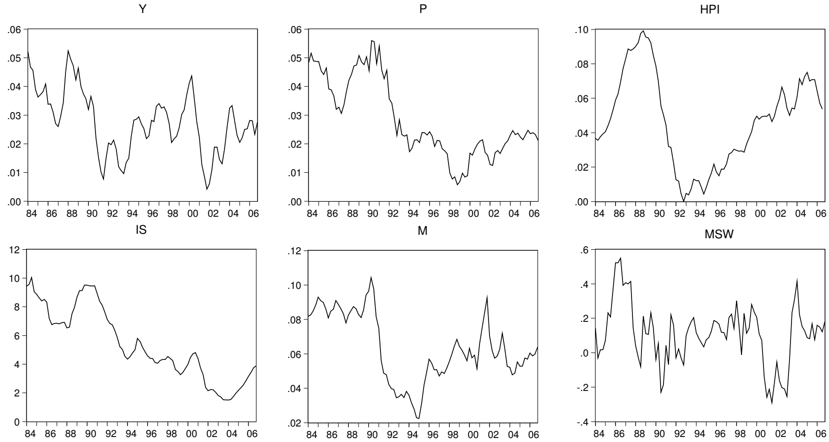

Figure 2: Global series, 4-quarter moving average of growth rates (except interest rate series), 1984Q1 - 2006Q4

clearly elucidates the moderate inflation which began around the mid-90s and has persisted in the recent years of global excess liquidity. House prices have shown a distinct appreciation especially in the last 5 years giving support, to some extent, to the popular asset price inflation hypothesis in the real estate sector. Global short-term interest rates were at a historically low level from 2002 to 2005, as the monetary policy stance was extremely loose during this period.[9]

4.2 The VAR Methodology

The econometric framework employed is a vectorautoregressive model (VAR) which allows us to model the impact of monetary shocks to the economy while taking care of the feedback between the variables since all of them are treated as endogenous.[10] Consider first the traditional reduced-form VAR model:

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

where Y_t is the vector of the endogenous variables and $\Gamma(L)$ is a matrix polynomial in the lag operator L for which $\Gamma(L) = I + \sum_{i=1}^{p} A_i L^i$, so that we have p lags. D_t is a vector with deterministic terms and the corresponding matrix of coefficients C, and u_t is the vector of the white noise residuals where serial correlation is excluded, so that:

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

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

Since Σ is not a diagonal matrix, contemporaneous correlation is allowed for. In order to model uncorrelated shocks, a transformation of the system is needed. Using the Cholesky decomposition $\Sigma = PP'$, taking the main diagonal of P to define the diagonal matrix D and premultiplying (1) with $\mathcal{A} := DP^{-1}$ yields the structural

[9] One might regard the deviation from a Taylor rate as a more accurate measure in this respect. However, these numbers create a similar picture. See International Monetary Fund (2007), Chapter 1, Box 1.4.

[10] Of course, one could model exogenous variables as well, but this option is not used here.

VAR (SVAR) representation:

$$K(L)Y_t = C^* D_t + e_t \quad (4)$$

$$K(L) = \mathcal{A} + \sum_{i=1}^{p} A_i^* L^i \quad (5)$$

The contemporaneous relations between the variables are now directly explained in $\mathcal{A}$, which is a lower triangular matrix with all elements of the main diagonal being 1. The innovations e_t are by construction uncorrelated since $E(e_t e_t') = \mathcal{A}\Sigma\mathcal{A}^{-1} = \mathcal{A}PP'\mathcal{A} = DP^{-1}PP'P^{-1'}D' = DD'$. Similarly, the Cholesky decomposition is used to construct orthogonal innovations from the moving average representation of the system which is the cornerstone of the impulse response analysis and the forecast error variance decomposition carried out later. Furthermore, the use of the Cholesky decomposition implies a recursive identification scheme which involves restrictions about the contemporaneous relations between the variables. These are given by the (Cholesky) ordering of the variables and might considerably influence the results of our analysis. Therefore, different orderings are used to evaluate the robustness of the results.

To compute standard errors for the impulse responses and the forecast error variance decomposition which are not relying on any specific assumptions, in particular concerning the distribution of the coefficients, Monte Carlo techniques are an appropriate way to construct the desired confidence intervals.[11] Thus, this method will be used in the subsequent analysis.

Since the macroeconomic variables included in the analysis are likely to be non-stationary, the question arises whether one should take differences of the variables in order to eliminate the stochastic trend. Here, we follow Sims, Stock and Watson (1990) and estimate the VAR model in levels which, due to its simplicity, might be the more appropriate technique, too.

[11] See Enders (2003), p. 277-278.

4.3 Empirical findings

The basic model

The conceptual approach of our VAR analyisis is as follows. First, a benchmark model for the traditional macroeconomic variables Y, P, IS and M is estimated. Second, when the dynamics of the system are found to be plausible at the global level, this is considered as a confirmation of our global approach, and the asset price variables HPI and MSW will be added one by one. The basic specification is given by the following vector of endogenous variables (with the corresponding Cholesky ordering):[12]

$$x_t = (y\ p\ IS\ m)'_t$$

The Cholesky ordering of the basic specification follows the principle that monetary variables should be ordered last, since they are supposed to react faster to the real economy than vice versa (Favero, 2001). Variables are taken in log-levels except for the short-term interest rate, and a constant and a linear time trend are added to the model. The usual criteria are applied to determine the lag length.[13] Most of the criteria point at a lag length of 2, which is also sufficient to avoid serial correlation among the residuals and seems to be appropriate in order to estimate a parsimonious model where possible.[14] While this is true not only for the benchmark specification but also for the following models we will continue with 2 lags for the whole analysis.

Figure 3 shows the complete impulse responses from the basic specification. Output declines with an interest rate shock and increases with a liquidity shock, which is in line with our expectations, but both effects are not significant at the 5% level. Prices move upwards through an innovation to the output variable which might give support to the consideration of the output gap in assessing inflationary pressures. The particularly interesting reaction of prices to a global liquidity shock is only slightly significant after a few periods, but the significance (and the level of the impact) increases over time. We interpret this in favour of the hypothesis that

[12] Lower case variables denote logarithms.

[13] Explicitly, the Likelihood Ratio test, the Final Prediction Error, the Akaike information criterion, the Schwarz criterion and the Hannan-Quinn criterion are used.

[14] To test for autocorrelation of the residuals, we performed the Lagrange Multiplier test.

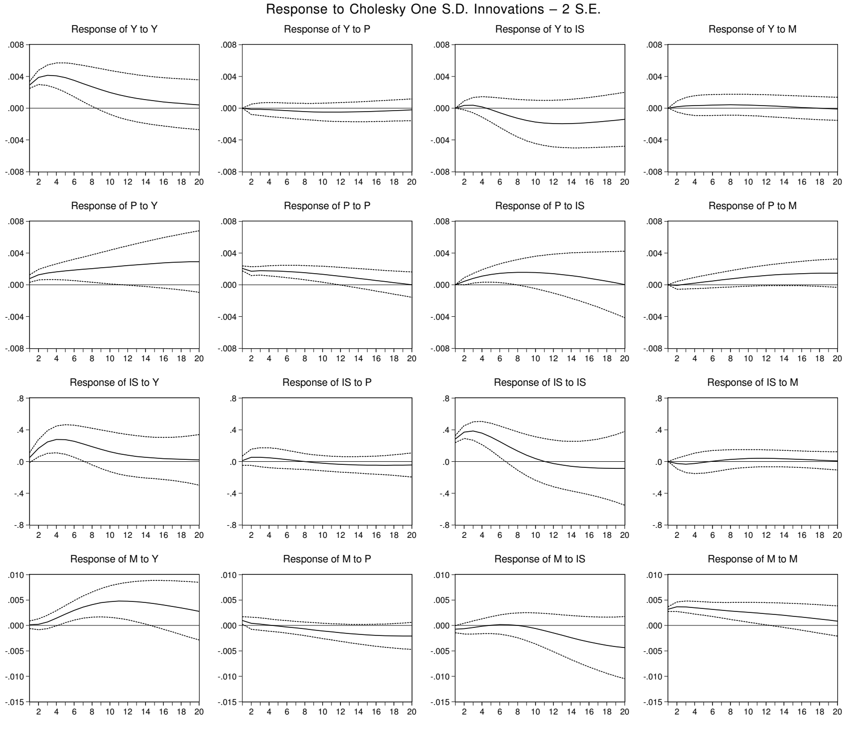

Figure 3: Impulse response analysis; basic model

the influence of money for inflation has a long-term character. In the case of the interest rate shock, the reaction of the price level yields the "price puzzle" which often occurs in the VAR analysis and was also faced by Rüffer and Stracca (2006) as well as Sousa and Zaghini (2006) in the same context. The appearance of the "price puzzle" is sometimes thought to be caused by the lack of a variable which captures inflation expectations (Greiber, 2007). Monetary policy makers are supposed to raise interest rates when inflation expectations rise. When their policy cannot stop inflation from rising, the system may identify the rise of interest rates as a trigger of the increase in the price level. Therefore, it is recommended by Favero (2001) to use a commodity price index that might capture inflation expectations to some degree and may solve this problem. We considered this alternative and added a commodity price index and the oil price as complements of our system, but, still, the "price

Table 1: Forecast error variance decomposition of P, basic model

Period	Y	P	M	IS
2	23.2	74.8	0.1	1.9
	(8.7)	(8.6)	(0.9)	(2.0)
4	31.4	59.2	0.3	9.1
	(10.9)	(11.1)	(1.6)	(5.6)
8	37.5	41.6	2.3	18.5
	(13.5)	(12.6)	(3.9)	(10.5)
16	50.2	23.3	9.1	17.4
	(17.2)	(11.0)	(8.3)	(13.8)

Cholesky Ordering: Y P IS M; Standard Errors in parentheses

puzzle" did not disappear.[15] There will be further discussion of the "price puzzle" in the context of the following models, where the house price index helps us to solve the "price puzzle".

The short-term interest rate moves up due to an output shock, but does not show a significant reaction to a price or a money shock. These results may occur, because either the system captures only the monetary policy stance in the short run which could be dominated by the business cycle or because the monetary policy instrument might be difficult to model from a global perspective where different central banks with different strategies exist. The responses of money show, according to standard money demand considerations, a positive response of money to an output innovation and a decline of liquidity with growing interest rates. The latter effect might be caused by rising opportunity costs of money holdings and/or due to central bank driven shifts in the money supply.

Table 1 shows the forecast error variance decomposition of the GDP deflator. Liquidity matters again in the long run, while most of the variance of the price level is a result of fluctuations of the output variable. Notwithstanding the close long-run relationship between money and prices, in the short run, business cycle fluctuations seem to play the major role for price level volatility.

Overall, the results of the benchmark model provide a good starting point for the

[15] The same finding appears in Rüffer and Stracca (2006) as well as Sousa and Zaghini (2006) as these authors used commodity prices as well but did not solve the "price puzzle".

subsequent analysis in which the additional inclusion of asset price variables might strengthen the explanatory power of the global model.

Augmenting the VAR with asset prices

The next step in the VAR analysis is to allow for the first asset price variable to enter the model. We start with the house price index (HPI), since – according to section 3 – house prices may play a crucial role in this context. In the Cholesky ordering, we put house prices just behind the GDP deflator, so that we are working with the following vector of endogenous variables:

$$x_t = (y\ p\ hpi\ IS\ m)'_t$$

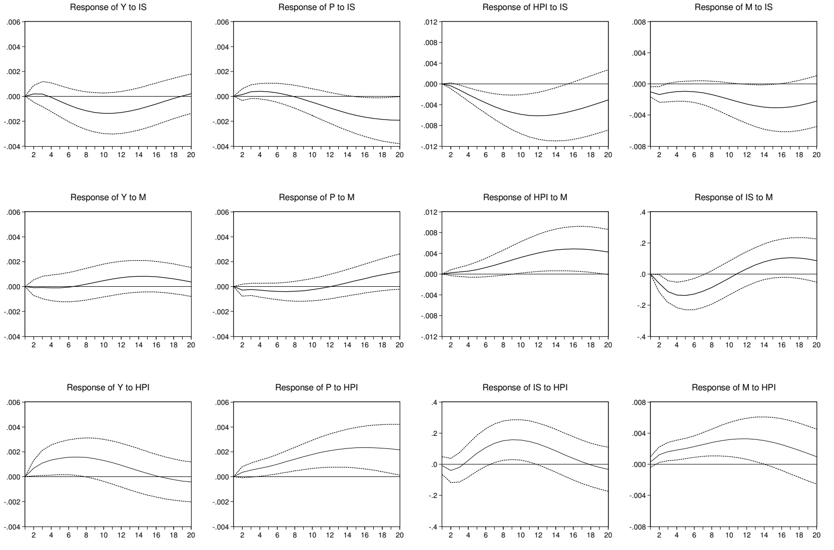

Figure 4: Impulse response analysis; basic model augmented with house prices

Figure 4 shows in the first row the effects from a positive shock to the short-term interest rate. Like in the benchmark model, this kind of shock causes output and money to decline, while the latter becomes significant at the 5% level here. Moreover, the "price puzzle" disappears which supports the view that house prices are essential for our model and otherwise an omitted variable bias might occur. Alternatively, one could argue that house prices and inflation expectations might be correlated, since the lack of an inflation expectation variable is often supposed to be the reason for the existence of the "price puzzle". The liquidity shock impact on the price level is slightly lower than in the basic model. However, by adding up both effects that may represent (recent) expansionary monetary policy (money and interest rate shock), we assess substantial upward pressures on inflation, while, once again, the long time lags of these effects have to be taken into account.

The responses of the house price index to the interest rate and to liquidity are significant over quite a long period. Both graphs support our view that loose monetary policy and ample global liquidity have contributed to the hausse in the real estate sector which is in line with our theoretical considerations. Analysing a house price shock, which may be especially relevant in the present situation, gives some additional insights. A house price shock raises liquidity which may not least be due to rising credit demand. This evidence is not surprising given the cointegration relationship between money and house prices found by Greiber and Setzer (2007) for the Euro area and the US, and renders further support to the assumption that housing should be considered in money demand models. More surprisingly, a house price shock causes a rise in interest rates (row 3, column 3). Since it has not been commonly known until now that monetary policy makers are reacting directly to house price developments,[16] this raises again the question to what degree house prices are linked with inflation expectations or forecasts, respectively.

Table 2 displays the forecast error variance decomposition for the house price index and the price level. Over the long term (forecasting 16 quarters), the monetary variables (money and the interest rate) are responsible for nearly half of the volatility in the housing sector. This confirms the results of the impulse response analysis that both liquidity and interest rates are important determinants for pricing in the real estate sector. House prices themselves are causing a great percentage of price level forecast volatility, namely over 40% after 16 quarters. In combination with the corresponding impulse responses, this supports the existence of spill-overs

[16] For now, the subprime crisis ought to contribute to a changing behaviour in this respect.

Table 2: Basic model augmented with house prices

Forecast Error Variance Decomposition of HPI:					
Period	Y	HPI	P	M	IS
2	0.0	98.0	0.9	0.3	0.7
	(1.9)	(3.5)	(2.6)	(0.8)	(1.2)
4	0.3	87.8	3.2	0.8	7.9
	(3.0)	(7.4)	(4.5)	(1.8)	(5.0)
8	0.5	66.4	6.3	3.4	23.3
	(4.6)	(12.1)	(6.3)	(4.2)	(10.1)
16	0.2	41.7	9.0	14.7	34.3
	(6.5)	(14.2)	(7.5)	(9.4)	(12.8)
Forecast Error Variance Decomposition of P:					
Period	Y	HPI	P	M	IS
2	18.5	1.6	78.7	1.0	0.2
	(8.4)	(2.0)	(8.6)	(1.8)	(1.2)
4	25.0	5.3	66.2	1.4	2.1
	(10.6)	(5.1)	(11.0)	(2.5)	(3.0)
8	33.2	17.4	45.4	2.4	1.6
	(12.8)	(10.2)	(12.6)	(3.6)	(3.6)
16	23.4	44.5	18.8	1.9	11.3
	(13.4)	(13.4)	(8.9)	(3.5)	(7.6)
Cholesky Ordering: Y P HPI IS M					
Standard Errors in parentheses					

from housing price inflation to consumer prices from an empirical angle. From a theoretical point of view these findings underline the relevance of wealth effects and the balance sheet channel, which probably contribute to these spill-overs.

The house price index in our model does not only solve the "price puzzle", it is also involved in many significant impulse responses and is a major factor in the forecast error variance decomposition of the price level. Therefore, the house price variable is too crucial to be omitted in the following. Consequently, we will augment our model with stock prices while still including the house price index.

We now add the log of the MSCI World index to our model to represent global stock markets. The vector of variables under consideration is therefore (in a Cholesky ordering):

$$x_t = (y\ p\ hpi\ IS\ m\ msw)'_t$$

Figure 5 shows a selection of the impulse responses representing the relationships that are of primary interest. No evidence can be found that either interest rate shocks or liquidity shocks fuel stock markets. Furthermore, no significant spill-overs from share prices to inflation occur in our model. At least, there is a significant response of money to a stock market impulse. This may be due to wealth effects

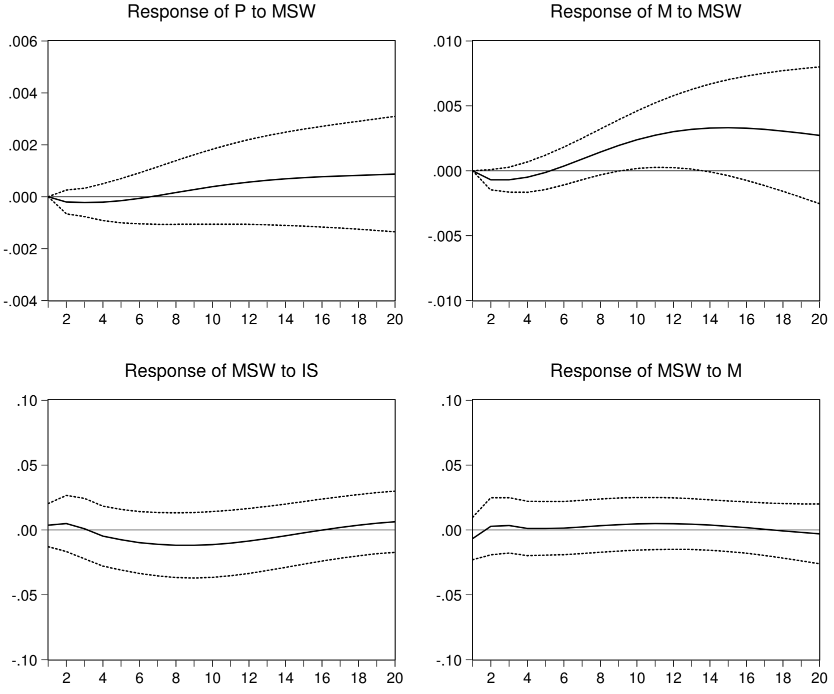

Figure 5: Impulse response analysis; model with house prices and stocks

with respect to money demand. As rising share prices contribute to wealth, and with money demand depending more on wealth than on income, this effect makes sense from a theoretical perspective.[17] Note that these results are robust to an estimation of the model in which only share prices and not the house price index are included.

We propose at least two possible interpretations for our finding that stock prices do not react to monetary conditions. Either share prices are difficult to model adequately within a standard macroeconomic framework or they are mainly determined by fundamental criteria like future cash flow expectations or price earnings ratios assuming that the latter are independent from monetary policy. Thus, the special role we found for house prices among asset prices in our theoretical considerations is clearly confirmed in our empirical investigation.

[17] See European Central Bank (2007) for some recent empirical findings that show a close link between money and wealth in the Euro area.

4.4 Robustness checks

To evaluate the robustness of our results, we estimated several alternative versions of our model. First, we changed the Cholesky ordering of the variables and, additionally, used generalized impulse responses.[18] For instance, the interest rate is often ordered behind the money variable in similar VAR models, so that we also tried this option with nearly no consequences for the results. The same is true for generalized impulse response analysis. Second, additional variables were added to the model, namely a commodity price index (like already mentioned earlier), the oil price (as an alternative for the commodity price index) and a long-term interest rate (specified by 10-year government bond yields). Both former variables were involved in only very few significant impulse responses with the most interesting of them being a short-term rise of the interest rate to a commodity price shock. The other findings of our model again proved to be stable. As the commodity price index and the oil price did not solve the "price puzzle" and did not show significant effects on the price level, we dropped them in the analysis illustrated above not least in order to save degrees of freedom.

The long-term interest rate was added as a substitute for the short-term rate and as a complement of our system as well. In the former case, results were very similar to the use of the short-term rate. In particular, no evidence was found that global liquidity fuels bond markets. When using both rates signs of duplications were found. For instance, shocks to both rates caused a decline of the GDP deflator and the house price index. Notwithstanding the fact that the long-term interest rate might contain additional information, the relationship to the short-term interest rate seems to be close enough such that the more parsimonious model may be more adequate in order to diminish overparameterization. As a third aspect, different lag lengths were used. Particularly, 4 lags were tried, but no contradicting results occurred.

[18] See Pesaran and Shin (1998) for theoretical derivations of generalized impulse response analysis.

5 Conclusions

So does the inclusion of house prices help to restore a significant monetary transmission process from global excess liquidity to macro variables? And more specifically: does global liquidity spill over to house prices? The main empirical results of our paper in this respect are the following: At a global level, we find further support to the conjecture that monetary aggregates may convey some useful information on variables such as house prices which matter for aggregate demand and hence inflation. Thus, we conclude that excess liquidity is a useful indicator of house price inflation and of a more generally defined inflationary pressure at a global level. Therefore we would like to argue that global liquidity merits some attention in the same way as the worldwide level of interest rates as in the recent hot debate about the world savings versus liquidity glut, if not possibly more.

The still high level of global liquidity can be seen as a threat for future inflation and financial stability. Since global excess liquidity is found to be an important determinant regarding house prices there might be at least two implications. First, monetary policy has to be aware of likely spill-overs from housing to consumer prices resulting from the hausse in the real estate sector which might continue due to excess liquidity. Secondly, when house prices reach an unsustainable level and a potential bubble is created, this means risks not only for price stability but also for the economy as a whole - as seen in the current subprime crisis which apparently has partly spread from the US to other parts of the world. We also see some implications for policy makers. In the first place, our VAR analysis indicates that house prices might well serve as indicators of future inflationary pressures. Moreover, strong monetary growth might be a good indicator of emerging bubbles in the real estate sector.

We see two potential ways to reduce the world excess liquidity. The first is a tightening of monetary policy oriented at the development of the world's nominal income. This strategy will not solve the current problem immediately but should diminish the long-run risks. Moreover, fostering strong global economic growth will dampen negative effects especially with respect to potentially bursting bubbles.

As always, some important questions remain unanswered in this paper. Let us just mention two of them. First, over the last 30 years, the Euro area index for real housing prices has tended to follow that of the US quite closely, but with a lag of around 18 months. Given that the US market turned in mid-2006, one could thus expect that the Euro area market is likely to do the same as 2007 turns into 2008 (Gros, 2007). Will the world excess liquidity in the end be capable to stop this trend? Second, there is still empirical work missing which augments *national* VAR models with *foreign* money. We leave these tasks for future research.

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