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Liquidity and the dynamic pattern of price adjustment: a global view

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Abstract:

Global liquidity expansion has been very dynamic since 2001. Contrary to conventional wisdom, high money growth rates have not coincided with a concurrent rise in goods prices. At the same time, however, asset prices have increased sharply, significantly outpacing the subdued development in consumer prices. This paper examines the interactions between money, goods and asset prices at the global level. Using aggregated data for major OECD countries, our VAR results support the view that different price elasticities on asset and goods markets explain the recently observed relative price change between asset classes and consumer goods.

Keywords: E31, E52, F01, F42

JEL-Classification: Global liquidity, inflation control, monetary policy transmission, asset prices

Non technical summary

Money growth has been very dynamic in many regions in recent years. At the same time, consumer price inflation has been comparatively stable, therefore putting into question the long-term relationship between monetary and price developments. However, this paper shows that a subdued consumer price inflation may be quite consistent with strong monetary growth if the developments in the asset markets are taken into account.

The basic idea is that different price elasticities of supply lead to differences in the dynamic pattern of price adjustment to a global liquidity shock. While goods prices adjust only slowly to changing global monetary conditions due to an elastic supply of consumer goods not least from emerging markets, asset prices such as housing and commodity prices react much faster since the supply of real estate and commodities cannot be easily expanded.

Using aggregated data for major OECD countries, our empirical results support the view that different price elasticities on asset and goods markets are to a large extent able to explain the recently observed relative price changes between asset classes and consumer goods. In line with theoretical reasoning, the reaction of asset prices to a monetary shock takes place faster than that of goods prices. We also find that monetary aggregates may convey useful and stable leading indicator information on variables such as house prices, gold prices, commodity prices and the GDP deflator at the global level. Finally, our results suggest that there are significant spill-over effects from house price to goods price inflation suggesting that a forward-looking monetary policy has to take asset price developments into account.

Nicht technische Zusammenfassung

Das Geldmengenwachstum war in den vergangenen Jahren in vielen Regionen der Welt außerordentlich stark. Vor dem Hintergrund der gleichzeitig verhaltenen Konsumentenpreisentwicklung hat dies dazu geführt, dass der Geldmengen-Preiszusammenhang von einigen Beobachtern in Frage gestellt wurde. Die vorliegende Studie verdeutlicht jedoch, dass eine gedämpfte Verbraucherpreisinflation durchaus mit hohen Geldmengenwachstumsraten vereinbar ist, wenn die Entwicklung an den Vermögensmärkten in die Entwicklung miteinbezogen wird.

Ausgangspunkt ist die Überlegung, dass Konsumgüter- und Vermögenspreise unterschiedliche Angebotselastizitäten aufweisen. So reagiert das Angebot an Konsumgütern nicht zuletzt in Folge globalisierter Gütermärkte vergleichsweise flexibel auf veränderte monetäre Bedingungen. Preiswirkungen stellen sich demnach erst längerfristig ein. Vermögenspreise wie Immobilien oder Rohstoffe reagieren dagegen schneller auf Nachfrageschwankungen, da der Bestand an Grund, Boden und Rohstoffen in der kurzen Frist relativ starr ist.

Unsere empirischen Ergebnisse stehen im Einklang mit diesen theoretischen Überlegungen. Auf Basis von aggregierten Daten für die wichtigsten OECD-Länder finden wir, dass unterschiedliche Preiselastizitäten auf Vermögens- und Gütermärkten Relativpreisverschiebungen zwischen Vermögens- und Verbraucherpreisen zu erklären vermögen. Die Preisreaktion der Vermögenspreise auf eine veränderte Liquiditätsaustattung fällt dabei schneller aus als die der Güterpreise. Zudem weisen globale monetäre Aggregate wichtige Vorlaufeigenschaften für Häuserpreise, Rohstoffe, Gold und den BIP-Deflator auf. Schließlich deuten unsere Ergebnisse auf signifikante spill-over Effekte von Häuserpreisen zu den Konsumentenpreisen hin, so dass eine stabilitätsorientierte Geldpolitik auch Entwicklungen auf den Vermögensmärkten in ihre Analyse mit einbeziehen sollte.

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Liquidity and the Dynamic Pattern of Price Adjustment: A Global View*

1. Introduction

Global liquidity has been expanding steadily since 2001. In most industrial countries and more recently also in some emerging market economies with a dollar peg, especially China, broad money growth has been running well ahead of nominal GDP. Surprisingly enough, for a long time goods price inflation had been widely unaffected by the strong monetary dynamics in many regions in the world. Only recently surplus liquidity poured into raw material, food and goods markets. Over the same time horizon, however, many countries have experienced sharp but sequential booms in asset prices, such as real estate or share prices (Schnabl and Hoffmann, 2007). Between 2001 and 2006, for instance, house prices strongly increased in the US (55%), the euro area (41%), Australia (59%), Canada (61%) and a number of further OECD countries; the HWWI commodity price index surged by 110% in the same period and stock prices more than doubled in nearly all major markets from 2003 to 2006. Many observers interpret the sequence of increases of asset prices as the result of liquidity spill-overs to certain asset markets (Adalid and Detken, 2007, Greiber and Setzer, 2007).

From a monetary policy perspective, the different price dynamics of assets and goods prices in recent years raises the question as to whether the money-inflation nexus has been changed (thereby calling into question the close long-term relationship between monetary and goods price developments that was observed in the past) or whether effects from previous policy actions are still in the pipeline. To investigate the relative importance of these developments, this study tries to establish an empirical link between money, asset prices and goods prices. For this purpose, we estimate a variety of

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VAR models 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, South Korea, Australia, Switzerland, Sweden, Norway and Denmark) and analyse the impact of a shock to global liquidity on global asset and goods price inflation. The basic idea is that different price elasticities of supply lead to differences in the dynamic pattern of price adjustment to a global liquidity shock. While goods prices adjust only very slowly to changing global monetary conditions due to plentiful supply of consumer goods from emerging markets, asset prices such as housing and commodity prices react much faster since the supply of real estate and commodities cannot be easily expanded. Thus disequilibria on these markets are generally balanced out by price adjustments.

The main emphasis is on globally aggregated variables, which implies that we do not explicitly deal with spill-overs of global liquidity to national variables. The main motivation for this specific way of proceeding is heavily related to recent research according to which inflation appears to be a global phenomenon. So far, the relationship between money growth, different categories of asset prices and goods prices has been little studied in an international context. Only recently, a number of authors suggested specific interactions of global liquidity with global consumer price and asset price inflation (Baks and Kramer, 1999, Sousa and Zaghini, 2006, and Rüffer and Stracca, 2006). However, so far no study has tried to systematically analyze differences between asset classes and goods in the dynamic pattern of price adjustment to a global liquidity shock.

The remainder of the paper is organised as follows: in section 2, we convey an impression of the global perspective of the monetary transmission process. In section 3, we develop some simple theoretical considerations to illustrate the potential role of different supply elasticities as potential drivers of asset- and goods-specific price adjustments to global liquidity shocks. In section 4 we turn to an econometric analysis using the VAR technique on a global scale. Moreover, we conduct a wide array of robustness checks. Section 5 finishes with some policy conclusions.

2. The global perspective of monetary transmission

Both with respect to global inflation and to global liquidity performance, available evidence becomes stronger that the global instead of the national perspective is more important when the monetary transmission mechanism has to be identified and interpreted. For instance, Ciccarelli and Mojon (2005) find empirical evidence in favour of a robust error-correction mechanism, meaning that deviations of national inflation from global inflation are corrected over time. Similarly, Borio and Filardo (2007) argue that the traditional way of modelling inflation is too country-centred and a global approach is more adequate. Considering the development of global liquidity over time, the question is often raised whether and to what extent global factors are responsible for it. Rüffer and Stracca (2006) investigate this 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. One prominent example of such a global factor is, for instance, the expansionary monetary policy stance of the Bank of Japan (BoJ) during the last years. 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 up loans in Japan and invested the proceeds in currencies with higher interest rates. Such kind of capital transactions has impacts on the development of monetary aggregates far beyond the special case of Japan and national borders in general (see, e.g., Schnabl and Hoffmann, 2007).

An additional argument in favour of focusing on global instead of national liquidity is that national monetary aggregates have become more difficult to interpret due to the huge increase of international capital flows. Simply accounting for the external sources of money growth and then mechanically correcting for cross-border portfolio flows or M&A activity, on the presumption of their likely less relevant direct effects on consumer prices, is not a sufficient reaction. Instead, these transactions have to be investigated with respect to their information content and potential wealth effects on residents' income and on asset prices which might backfire to goods prices as well (Papademos, 2007, p. 4, Pepper, 2006). In the same vein, Sousa and Zaghini (2006) argue that global aggregates are likely to internalize cross-country movements in monetary aggregates - due to capital flows between different regions - that may make the link between money, inflation and output more difficult to disentangle at the country level. Giese and Tuxen (2007) stress the fact that in today's linked financial markets shifts in the money supply in one country may be absorbed by demand elsewhere, but simultaneous shifts in major economies may have significant effects on worldwide asset and goods price inflation.

Some critics might argue that global liquidity, as measured in one currency, can only change in quantitative terms if one assumes a fixed exchange rate system worldwide. Note, however, that international liquidity spill-over effects may occur regardless of the exchange rate system. Under pegged exchange rate regimes official foreign exchange interventions result in a transmission of monetary policy shocks from one country to another. In a system of flexible exchange rates, the validity of the "uncovered interest rate parity" relationship should in theory prevent cross-border monetary spill-overs. According to this theory, the expected appreciation of the low-yielding currency in terms of the high-yielding currency should be equal to the difference between interest rates in the two economies. However, the enduring existence of carry trades can be taken as evidence that exchange rates diverge from fundamentals for lengthy periods, as the exposure of a carry trade position involves a bet that uncovered interest rate parity does not hold over the investment period. Note as well that exchange rates might quite rarely be considered as truly flexible across our estimation period anyway, as, for instance, Reinhart and Rogoff (2004) classify only 4.5% of the exchange rate regimes under their investigation as "freely floating".

The concept of “global liquidity" has attracted growing attention in the empirical literature in recent years. One of the first studies in this field is Baks and Kramer (1999) who use different indices of liquidity in seven industrial countries to explore the dimension of the relationship between liquidity and asset returns. The authors find evidence that there are important common components in G7 money growth and that an increase in G7 money growth is consistent with higher G7 real stock returns and lower G7 real interest rates.

Recently, a number of studies have applied VAR or VECM models to data aggregated on a global level. Important contributions include Rüffer and Stracca (2006), Sousa and Zaghini (2006) and Giese and Tuxen (2008). These studies find significant and distinctive reaction of consumer prices to a global liquidity shock. In contrast, the relationship between global liquidity and asset prices is mixed. In the study by Rüffer and Stracca (2006), e.g., a composite real asset price index that incorporates property and equity prices does not show any significant reaction to a global liquidity shock. Giese and Tuxen (2007) find no evidence that share prices increase as liquidity expands; however, they cannot empirically reject cointegrating relationships which imply a positive impact of global liquidity on house prices.

3. The price adjustment process

As far as the impact of monetary policy on asset prices is concerned, the most recent and innovative studies are – with an eye on the subprime crisis not surprisingly - concerned with the relationship between monetary policy and house prices. However, we will show below that large parts of the arguments can be transferred without major modifications to other asset classes as well. Some authors have recently emphasized the role of housing for the transmission of monetary policy, although drawing on interest rate changes as policy instruments rather than on changes in money aggregates (see e.g. Del Negro and Otrok, 2007, Giuliodori, 2005, Goodhart and Hofmann, 2001, Mishkin 2007, and Iacoviello, 2005).

Recently, the global aspects of house price developments have gained importance. A study by the IMF deals with this issue and analyses the recent house price boom from a global point of view.[1] Similar to some of the studies mentioned above a factor analysis is performed and a global factor is extracted. It is estimated that 40% of national house price developments can be explained by global factors. The study concludes that there are strong international linkages of the factors that determine house prices and that the recent house price bubble is indeed a highly global phenomenon. There are at least two possible explanations for these findings. First, there is empirical evidence for the existence of a global business cycle (Canova, 2007) and since house prices are meant to move largely pro-cyclically, this can be seen as one major common force that drives house prices all over the world. Second, if there are arbitrage relationships between house prices and globally traded securities like shares, the global factors that affect

1 See the essay "The Global House Price Boom" in International Monetary Fund (2004), chapter 2.

these securities influence house prices as well (think, for instance, of a global stock market crash).[2]

One aspect which has been largely neglected by the previous literature is why house prices (and other asset prices) have risen so sharply in recent years while consumer price development has been subdued. Some insights into the relationship between money, asset prices and consumer prices can be derived from the dynamic price adjustment to a liquidity shock across different sectors of the economy. In the short term, an expansionary monetary policy providing the markets with more liquidity should trigger an immediate price reaction in sectors with low price elasticity of supply, but a more subdued price reaction in sectors with high elasticity of supply. Over time, however, elastic good prices also adjust to the new equilibrium by proportional changes of the price level, i.e. it is plausible to argue that in the long term changes in money supply do not lead to any effects on real money or real output.

Figure 1 illustrates (in an extreme form) the price-quantity changes as a result of a monetary expansion in markets with high (left graph) and low (right graph) price elasticity of supply. The aggregated supply of price elastic goods S_e in the short-term (SR) is characterized by infinite price elasticity so that additional demand triggered by a liquidity shock (from D_{e1} to D_{e2}) can be satisfied without any price increase. Consequently, the liquidity shock translates into an increase in output achieving a new short-term equilibrium at p_{e1}. In contrast, goods characterized by restrictions in supply cannot be expanded easily and are thus quantity insensitive to a monetary expansion. Additional demand (shift from D_{i1} to D_{i2}) is then fully reflected in a rise of house prices to p_{i1}.

In the long-term, prices will also react on the price elastic good market as the well-documented neutrality of money holds; any change in money supply is met with a proportional change in the price level that keeps real money and real output in both sectors unchanged (at p_{e2} and p_{i2}).

[2] See IMF (2004) for this argument.

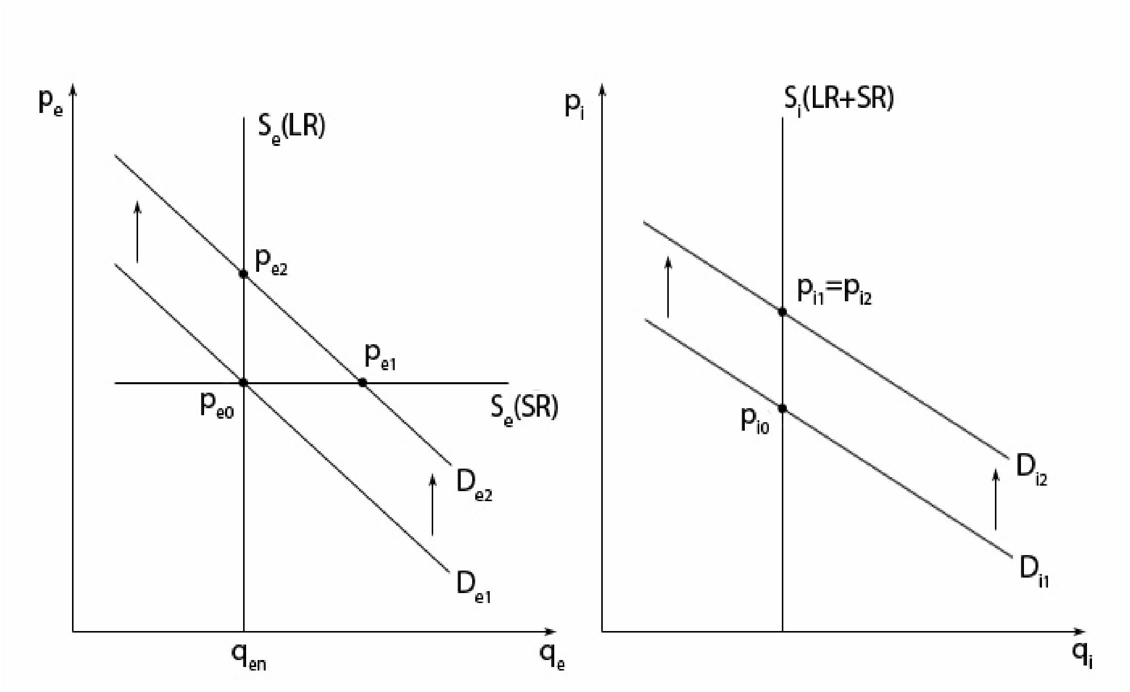

Figure 1: Short- and long-run impact of a liquidity shock to price elastic (left-hand side) and price inelastic good (right-hand side).

The possibility of different dynamic adjustments of price elastic and inelastic goods to a monetary shock may provide an explanation for the recent upward shift in relative prices between assets and consumer goods.

This assumption can be well motivated with developments in international trade. Due to high degree of competition in international goods markets and vast supply of cheap labour in many emerging markets around the world, which weighs heavily on the prices of manufactured goods, in the short-term goods prices remain unaffected by the increase in aggregate demand. Only in the long-term, increasing capacity utilization will translate into higher wages, putting upward pressure on prices.[3]

In contrast, assets such as housing, but also commodities are generally assumed to be restricted in supply. Land cannot be expanded easily (Japan) and/or all real estate transactions involve high costs (continental Europe). The latter implies that housing

[3] It is not our main concern in this paper to deliver a comprehensive explanation of house price bubbles. Rather, we would like to provide explanations for the recently observed relative shift between asset and goods prices and for the indicator properties of asset prices for consumer goods prices. In order to describe and to explain the roots of the subprime crisis itself (or bubbles in general) one needs models

supply is inelastic at least within a certain price interval.[4] Thus, additional demand for housing is immediately reflected in a rise of house prices.

Similarly, a number of constraints in the commodity market such as finite supply prevent producers in the commodity market from adjusting quantities to short-term price incentives. Moreover, as argued by Browne and Cronin (2007), the price adjustment process in commodity markets is relatively fast because participants are more equally empowered with more balanced information and resources than their consumer goods counterparts. This enables them to react quickly to changes in monetary conditions.

4. Empirical analysis

4.1 Data description and aggregation issues

In the following empirical analysis, we analyze whether monetary transmission corresponds with our prior that different price elasticities of supply determine the ordering of the different asset/goods classes in the transmission process of global liquidity. For this purpose we use quarterly time series from 1984Q1 to 2006Q4 for the United States, the euro area, Japan, United Kingdom, Canada, South Korea, Australia, Switzerland, Sweden, Norway and Denmark, so that in our analysis 72,2% of the world GDP in 2006 and presumably a considerably larger share of global financial markets are represented.[5]

For the aforementioned 11 countries, we gather real GDP (GDP), the GDP deflator (PGDP), the short term money market rate (IS), and a broad monetary aggregate (M). Further, to capture developments in asset and commodity markets, we include a nominal house price index (HPI) and the HWWI commodity price index (COM).[6] The latter is already a global variable (measured in US dollars) so that no aggregation is needed. The monetary aggregate we use is M2 for the US, M3 for the

which contain elements of misguided expectation formation. See Allan, Morris and Shin (2003), Gorton (2008) or, for a survey, Belke and Polleit (2006).

4 For a detailed discussion of the relevance of these arguments see Gros (2007), OECD (2005) and Shiller (2005).

5 Own calculations based on IMF data.

6 The HWWI commodity price index provides an encompassing gauge of price trends in commodity markets. It consists of crude oil (63%), industrial raw materials (23%), coal (4%), and foodstuffs (10%).

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 OECD, the BIS and the ECB and are seasonally adjusted if available or treated with the X12-ARIMA procedure.[7]

In the next step, we aggregate the country-specific series to obtain global series considering the principles mentioned by Beyer, Doornik and Hendry (2000) and employing the method as used by Giese and Tuxen (2007) in the same context. First, we calculate variable GDP weights for each country by using market exchange rates to convert nominal GDP into a single currency. This is in contrast to previous literature which has mostly relied on aggregation by purchasing power exchange rates. However, precise purchasing power rates are difficult to measure and not uncontroversial. Moreover, as a stylized fact, deviations from actual and purchasing power rates have proven to be quite persistent and should therefore not be neglected (Taylor, 2000). Nevertheless, we check for the sensitivity of our results to the choice of exchange rates in our robustness section. The weight of a country *i* in period *t* therefore is:

$$w_{i,t} = \frac{GDP_{i,t} e_{i,t}}{GDP_{agg,t}} \qquad (1)$$

Second, we compute for each variable (measured in domestic currency) the growth rate, denoted by $g_{i,t}$ and aggregate them by using the weights calculated in (1):

$$g_{agg,t} = \sum_{i=1}^{11} w_{i,t} g_{i,t} \qquad (2)$$

Finally, *aggregate levels* are then obtained by choosing an initial value of 100 and multiplying with the computed global growth rates. This gives the level of each variable as an index:

$$index_T = \prod_{t=2}^{T} (1 + g_{agg,t}) \qquad (3)$$

This method is applied to all variables except the interest rate, for which aggregation is performed without calculating growth rates.

7 House price are based on OECD data (see Schich and Weth, 2008).

The main advantage of the chosen aggregation scheme is that it avoids a potential bias resulting from different national definitions of broad money. Given the different definitions of monetary aggregates across countries, the building of a simple sum of national monetary aggregates - a method frequently applied in the related literature - would under-represent countries with narrower definitions of the monetary aggregate and vice versa.

To illustrate the development of global liquidity since 1984, Figure 2 shows global monetary aggregates in absolute and relative terms as well as the inverse of income velocity of money. All three series find themselves above their time trend since about 2001 when monetary policymakers turned to a more expansionary policy in the course of the rapid downturn in stock markets and a number of further shocks such as September 11th.

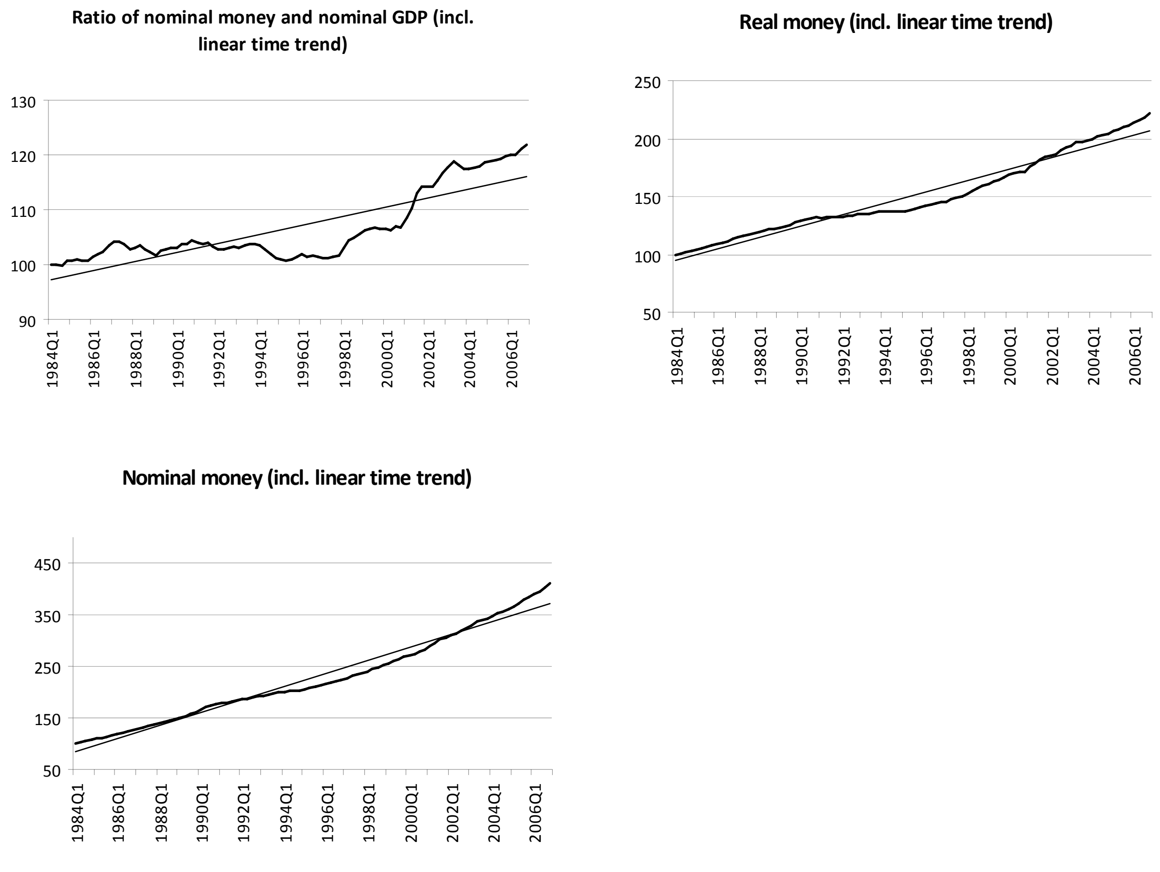

Figure 2: Global liquidity since 1984.

Money growth remained strong throughout the last years, as indicated by the persistent growth of the ratio of nominal money to nominal GDP – a measure frequently applied as an indicator of excess liquidity (see, e.g., Rüffer and Stracca (2006)). Overall, the graphical inspection provides some first glance for the view that global liquidity is indeed at a high level and that the term excess liquidity can be justified rather easily when analyzing the most recent period.

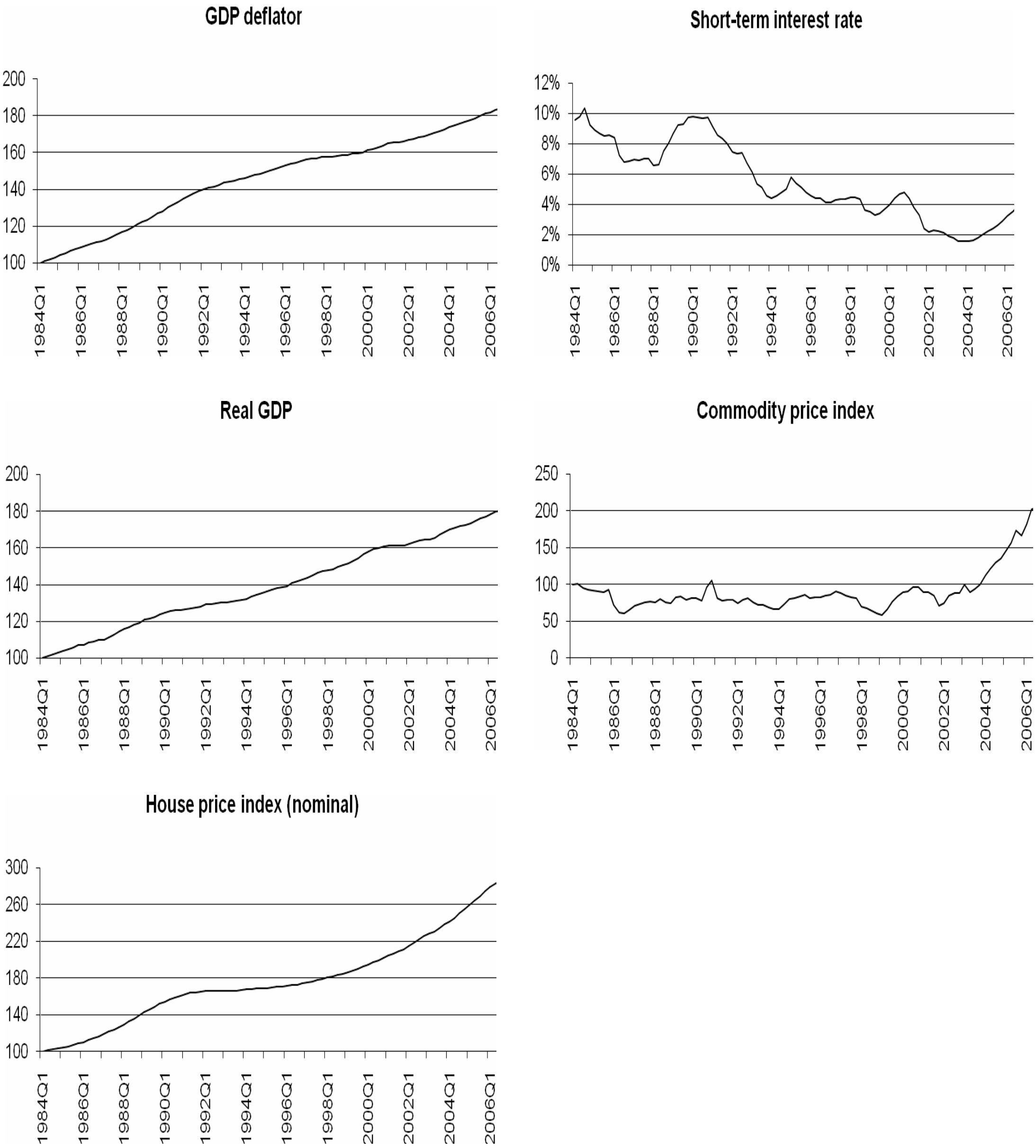

Figure 3: Global series of GDP deflator, short-term interest rate, real GDP, commodity prices and house prices.

Figure 3 displays the remaining aggregated economic variables of interest. The GDP deflator series clearly elucidates the moderate inflation which started to emerge around the mid-90s and has persisted until 2006 although monetary aggregates expanded heavily in recent years. Global short-term interest rates were at a historically low level from 2002 to 2005, since the monetary policy stance was extremely loose during this period.[8] Interestingly, the global time series show that the recent years of global excess liquidity are accompanied by strong price increases in both housing and commodity markets. The ongoing discussion about the linkage of global excess liquidity and asset price inflation is not least based on this phenomenon. In the following econometric analysis we will investigate the causal connection of global liquidity and asset and commodity price inflation in a more formal framework.

4.2 The VAR Methodology

The econometric framework employed is a vectorautoregressive model (VAR) which allows us to model the impact of monetary shocks on the economy while taking care of the feedback between the variables since all of them are treated as endogenous.[9] Consider first the traditional reduced-form VAR model:

$$\Gamma(L)Y_t = CZ_t + u_t \qquad (4)$$

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. Z_t is a matrix with deterministic terms, C is the corresponding matrix of coefficients, and u_t is the vector of the white noise residuals where serial correlation is excluded, so that:

$$E(u_t) = 0 \qquad (5)$$

$$E(u_t u_s^{\prime}) = \begin{cases} \Sigma : t = s \\ 0 : t \neq s \end{cases} \qquad (6)$$

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8 One might regard the deviation from an estimated Taylor rate as a more accurate measure in this respect. However, these numbers create a rather similar picture. See IMF (2007), Chapter 1, Box 1.4.

9 Of course, one could model exogenous variables as well, but this option is not used here. One reason is that we consider a world model, where there are no exogenous variables by definition. Moreover, from an econometric point of view, we refer to our point estimates. They reveal that no variable is weakly exogenous. Instead, all variables cannot be rejected to be endogenous.

Since Σ is not a diagonal matrix, contemporaneous correlation is allowed. 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 (4) with $\Psi := DP^{-1}$ yields the structural VAR (SVAR) representation:

$$K(L)Y_t = C^* Z_t + e_t \qquad (7)$$

$$K(L) = \Psi + \sum_{i=1}^{p} A_i^* L^i \qquad (8)$$

The contemporaneous relations between the variables are now directly explained in Ψ, which is a lower triangular matrix with all elements of the main diagonal being one. The innovations e_t are by construction uncorrelated: $E(e_t e_t^{|}) = \Psi\Sigma\Psi' = \Psi PP'\Psi' = DP^{-1}PP'P^{-1}{}'D' = DD'$. Similarly, the Cholesky decomposition is used to construct orthogonal innovations out of the moving average representation of the system which is the cornerstone of the impulse response analysis.

Furthermore, the use of the Cholesky decomposition implies a recursive identification scheme which involves restrictions about the contemporaneous relations between the variables. The latter are given by the (Cholesky) ordering of the variables and might considerably influence the results of the analysis. Therefore, different orderings are used to prove the robustness of our results.

Unit root tests indicate that all our series are integrated of order one. Thus the question arises whether one should take differences of the variables in order to eliminate the stochastic trend. However, Sims, Stock and Watson (1990) show that Ordinary Least Squares estimates of VAR coefficients are consistent under a broad range of circumstances even if the variables are nonstationary.[10] Therefore, we strictly follow this approach and estimate the VAR model in levels.

[10] Estimating the VAR in levels does not pose any problems, if all variables are stationary (I(0)). If some variables have a unit root (I(1)) and the series are not cointegrated, a VAR in levels or 1st differences makes no difference asymptotically. Taking first differences only tends to be better in samples smaller than ours (Hamilton, 1994, pp. 553, 652). However, if two or more variables are I(1) and cointegrated, the first difference estimates are biased if there is cointegration because the error-correction term is omitted. An alternative in the latter case would be to estimate a VECM. However, since it is hard to

4.3 Empirical findings

4.3.1 The baseline model

We are starting our VAR analysis by estimating a benchmark model which includes the traditional macroeconomic variables output (GDP), GDP deflator (PGDP), short-term interest rate (IS), and broad money (M). Further, we include the house (HPI) and the commodity price index (COM) in our model in order to test for different price reactions of assets and goods to a liquidity shock. In addition, a constant and a linear time trend are added. All variables are taken in log-levels except the interest rate. Our benchmark specification is thus given by the following vector of endogenous variables (along with the corresponding Cholesky ordering):

$$x_t = (GDP, PGDP, COM, HPI, M, IS)_t \qquad (9)$$

The Cholesky ordering of the basic specification follows the principle that monetary variables should be ordered last, since they are expected to react faster to the real economy than vice versa (Favero, 2001). The price variables *PGDP*, *COM* and *HPI* are ordered in the middle given that they are supposed to react to the monetary variables only with a lag. In general, the results are very robust to changes in the ordering within the three blocks. To determine lag length, we apply the usual criteria.[11] 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 model as parsimonious as possible.[12] While this is true not only for the benchmark specification but also for the following models we will continue with two lags for the whole analysis.

identify with any degree of accuracy the underlying structural parameters of a VECM which includes a large number of variables, for practical reasons we derive impulse responses from a VAR in levels, which due to its simplicity seems to be a more appropriate technique.

[11] To be explicit, we used the Likelihood Ratio test, the Final Prediction Error, the Akaike information criterion, the Schwarz criterion and the Hannan-Quinn criterion.

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

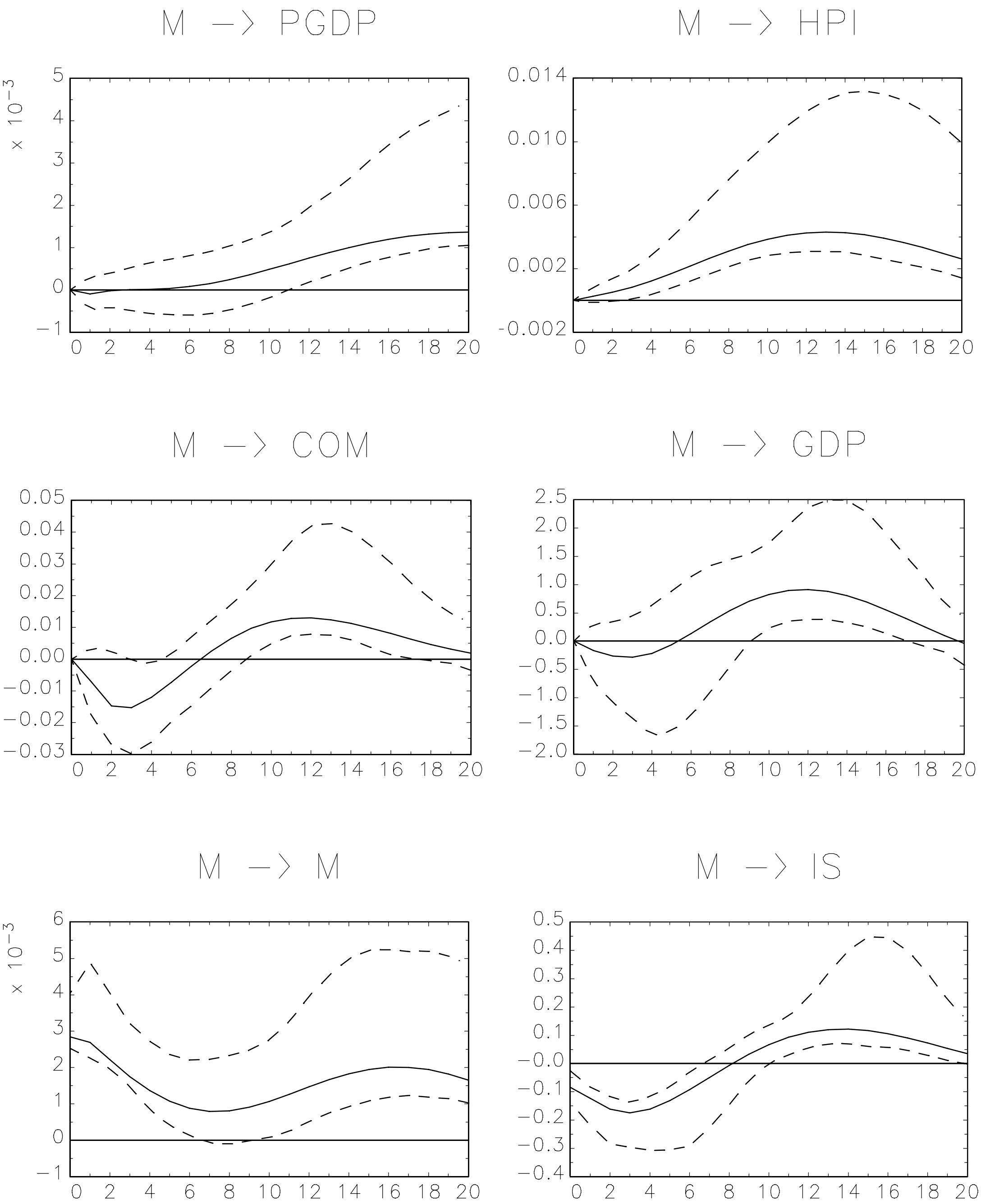

Figure 4: Impulse response analysis for benchmark specification[13]

Figure 4 displays the impulse responses with respect to an unexpected increase in global liquidity. (See the appendix for the whole array of impulse responses.) It has all

[13] The confidence intervals of our impulse responses display two standard deviations and are calculated via the studentized Hall bootstrap method.

features expected from our theoretical considerations: The GDP deflator reacts slowly but moves upwards significantly after about eleven quarters. Thus, in our model money matters for and causes goods price inflation although substantial time lags have to be taken into account. The length of the transmission lag is quite consistent with the literature on money-based inflation forecasting which suggests that monetary indicators are useful indicators for inflation over longer horizons (Hofmann 2006, Scharnagl and Schumacher 2007). Quicker positive responses to a global liquidity shock take place in case of the house price and the commodity price index (after three and nine quarters respectively). From a theoretical point of view, the lower price elasticity of supply in the housing and in the commodity market compared to the goods market should contribute to this finding.

It is also of interest that commodity prices react later than house prices to a shock of global liquidity. This is consistent with anecdotical evidence during the recent food price hike when global demand, driven by "hunger for return", turned to commodities after house prices had collapsed. On a more theoretical level, one could argue that house prices react faster than commodity prices to an unexpected increase in liquidity since expectations of future economic growth might be even more important for commodities than for real estate and, thus, shocks to global liquidity only pour into commodity markets when economic growth accelerates.[14] Moreover, speculation may play a more important role in housing markets. If assets *can* be stored, people expecting a price rise can take some amount off today's market, driving up the price now, in the expectation that they can sell it at a higher price later. Commodities which are characterized by a lower degree of storability than housing, then display less distinguished and slower price increases than housing (Krugman, 2008).

The remaining impulse responses of our benchmark model are also in line with economic theory. GDP moves up temporarily but not permanently as a result of a liquidity shock, which is in line with the theoretical assumption that money is neutral for the real economy in the long run. Interestingly, the price puzzle (the absence of a decline of the price level due to a positive interest rate shock), which is often found in similar VAR models, does not appear in our model (see Figure A1 in the appendix).

[14] Note the striking similarity in the impulse responses of a liquidity shock to output and to commodity prices.

Note also that the response of our variables to an interest rate shock is very consistent with the dynamic adjustment to a global liquidity shock. Further, it is of interest to see that house price shocks have predictive content for future goods price inflation suggesting that house prices should be taken into account by monetary authorities as they signal changes in expected goods price inflation (see Goodhart and Hofmann 2007 for similar results).

4.3.2 Augmenting the VAR with gold and stocks

Given that the dynamics of the benchmark model is found to be plausible, the next step in our VAR analysis is to augment our baseline model with further asset variables. Specifically, we include the gold price (in US dollars) and, alternatively, a globally aggregated stock price index in our model.[15] Similar to house and commodity prices these time series are characterized by significant upwards movements in recent years (Figure 5).

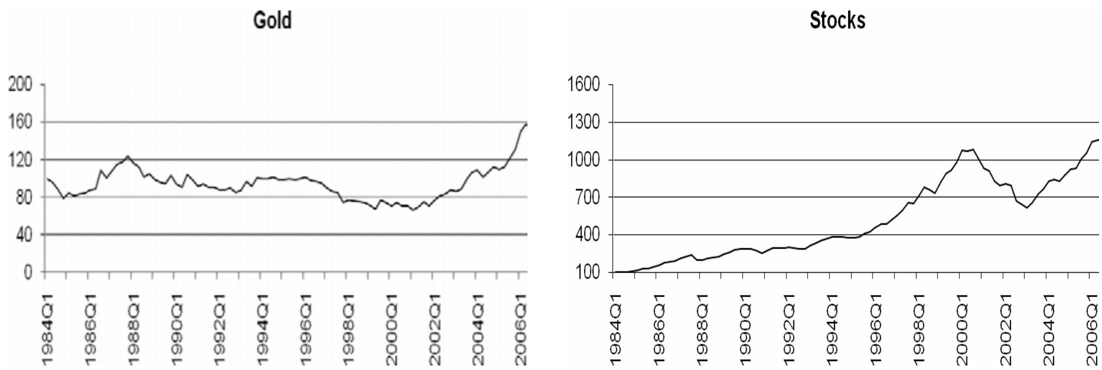

Figure 5: Gold and global stock prices.

Gold prices are of particular interest given that the actual amount of gold which can be produced in any year is only a minor share of the stock of gold. Thus the increase in the quantity of gold supplied in response to an aggregate demand shock is only a small fraction of the stock of gold, resulting a in a very steep supply curve.

[15] Note that the HWWI commodity price index does not include gold and thus there arise no problems of multicollinearity. Data for stock prices are from Datastream. For each country in our sample we use the key national stock market index and aggregate the series to a global index as described in section 4.1.

In the Cholesky ordering, we put gold just behind the house price index, given its assumed sensitiveness to monetary policy shocks; however, results are again very robust to changes in the ordering within the “price block”:

$$x_t = (GDP, PGDP, COM, HPI, GOLD, M, IS)_t \quad (10)$$

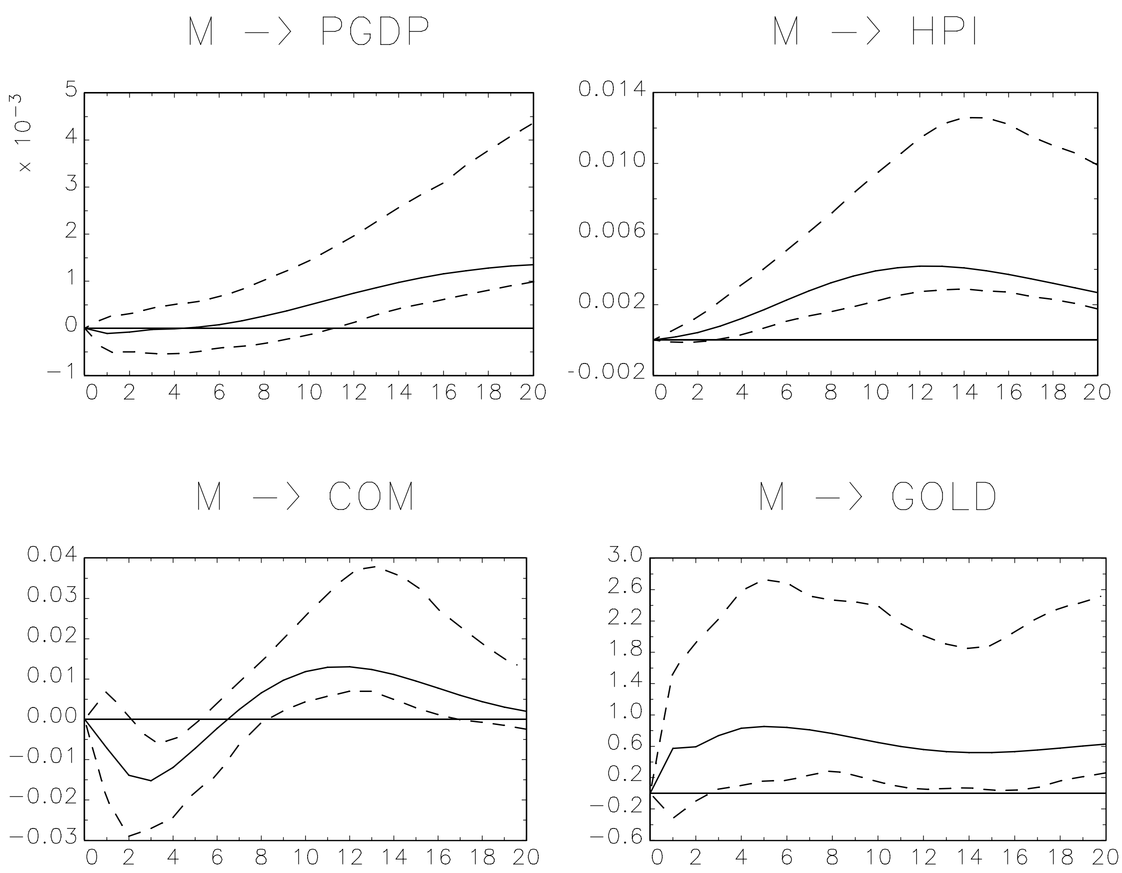

Figure 6: Impulse response analysis for model augmented with gold price.

Figure 6 displays the impulse responses of our extended model that are of main interest. Global liquidity shocks again positively and significantly influence the price level for goods and services (GDP deflator), housing and commodities. Interestingly, the response of the gold price is even faster. Gold prices react significantly after three quarters to an unexpected increase in global liquidity. This confirms our theoretical assumption that the price elasticity of supply is decisive to what degree global liquidity shocks are reflected in the price level. The quantity of gold cannot be easily extended so that the supply of gold is relatively price-inelastic and the reaction speed of the gold price is therefore quicker compared to other asset prices.

As a further alternative we substitute gold prices with the global stock price index. As a financial market variable, stocks are last in our Cholesky ordering so that we now have the following vector of endogenous variables:[16]

$$x_t = (gdp, pgdp, com, hpi, m, IS, stocks)_t \qquad (11)$$

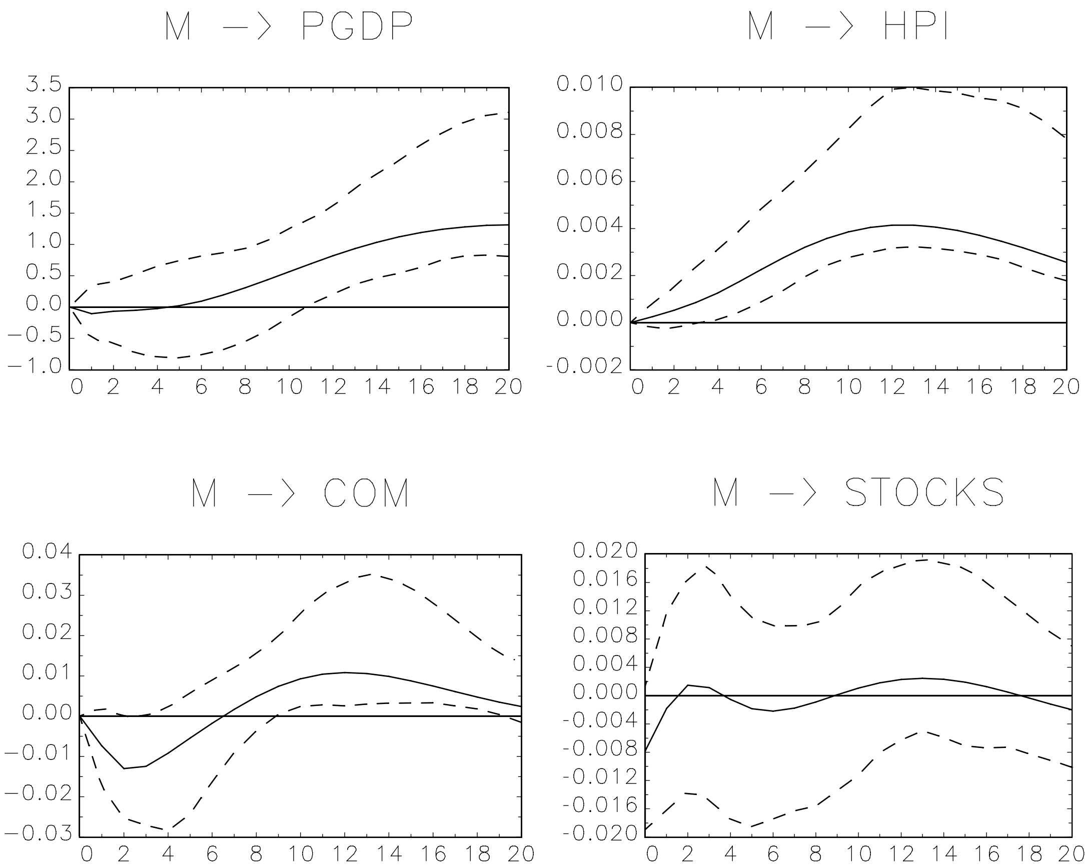

Figure 7: Impulse response analysis for model augmented with stock prices.

As can be seen in Figure 7, the positive and significant reactions of the GDP deflator, the house price index and the commodity price index to a global liquidity shock prove to be stable. However, stock prices do not show a positive response to a monetary impulse. This might serve as an indication that the relationship between

[16] Stock prices are often ordered last in similar VAR models. See e, e.g, Millard and Wells (2003) and Thorbecke (1997).

monetary developments and shares is less pronounced. One of the reasons is that the relationship between the developments in the stock market and money holdings is not clear cut. On the one hand, higher liquidity tends to increase household's assets, and a part of the associated asset growth may be held in the form of shares. On the other hand, high (expected) securities returns make the holding of shares more attractive than holding money. This may trigger important substitution effects, i.e. shifts between money and shares.

4.4 Robustness checks

To check for the robustness of our results, we additionally estimated several alternative versions of our model. First, we changed the lag lengths (especially 4 lags) with nearly no consequences for our results. Second, we used different Cholesky orderings in order to avoid that our results rely on any particular assumption regarding the structural equations of our VAR model. No major changes in the results occurred. Third, we used an alternative aggregation scheme for our global aggregates in order to find out if the results are sensible in this respect. As we used market exchange rates so far for the calculation of the individual country weights we also checked for the alternative of using PPP exchange rates in the aggregation procedure. (This results in a substitution in equation (1): $e_{i,t}^{PPP}$ instead of $e_{i,t}$).[17] Figure 8 displays selected impulse responses of our benchmark model when using PPP aggregation. (See Appendix A2 for the full set of impulse responses.) The main empirical findings are not affected. Global liquidity shocks again lead to a temporary increase of the output variable and to a permanent and significant increase of the GDP deflator, the house price index and the commodity price index. The high robustness of our results to the aggregation scheme should not come as a surprise given that many variables in our sample are highly correlated at an international level – a phenomenon which renders the form of aggregation less important.

[17] The base year for our PPP exchange rates is 1999.

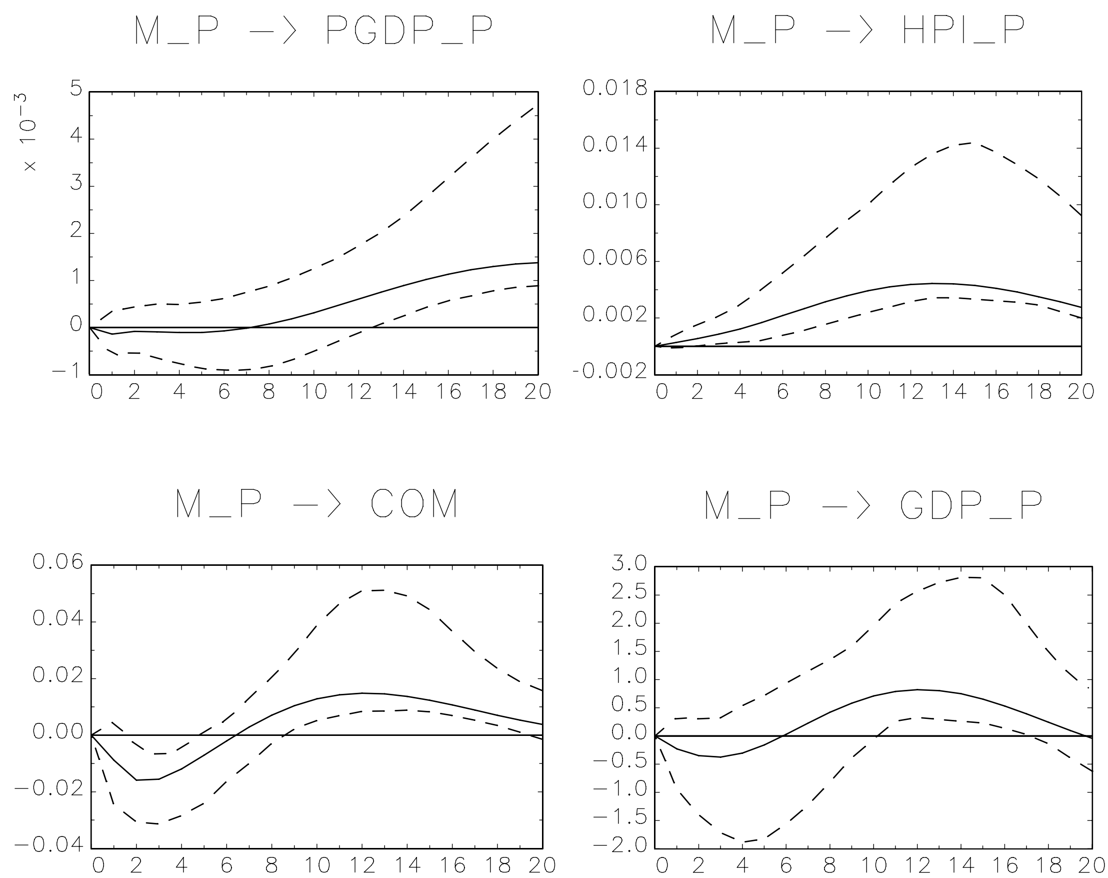

Figure 7: Impulse response analysis for benchmark specification; aggregation with PPP exchange rates.

5. Conclusions

In this paper, we have analyzed the effects of global liquidity shocks on goods prices and a variety of asset prices. We come up with the following empirical results: First, we find support of the conjecture that monetary aggregates may convey useful leading indicator information on variables such as house prices, gold prices, commodity prices and the GDP deflator at the global level. In contrast, stock prices do not show any positive response to a liquidity shock - a result which might be related to the relatively higher importance of substitution effects for this asset class. Second, our VAR results support the view that different price elasticities on asset and goods markets explain the recently observed relative price change between asset classes and consumer goods. In line with theoretical reasoning, the price reaction of asset prices takes place faster than that of goods prices. Third, we find significant spill-over effects from housing markets to goods price inflation suggesting that a forward-looking monetary policy has to take asset price developments into account.

Against the background of these results the still high level of global liquidity has to be interpreted as a threat for future stable and low inflation and financial stability. Since global excess liquidity is found to be an important determinant of asset and goods prices, there might be at least two implications for the adequate conduct of monetary policy. First, monetary policy has to be aware of different time lags in the transmission from liquidity to different categories of prices. In particular, strong money growth might be a good indicator of emerging pressure on inflation in the real estate sector and later on also of inflation in gold and commodity markets. However, it does not seem to be a good leading indicator for stock prices. Second, this pattern should, on the contrary, also be taken into account when assessing the consequences of a slowing down or smooth reversal in global excess liquidity - for instance, the risks and options in the light of Bretton Woods II.

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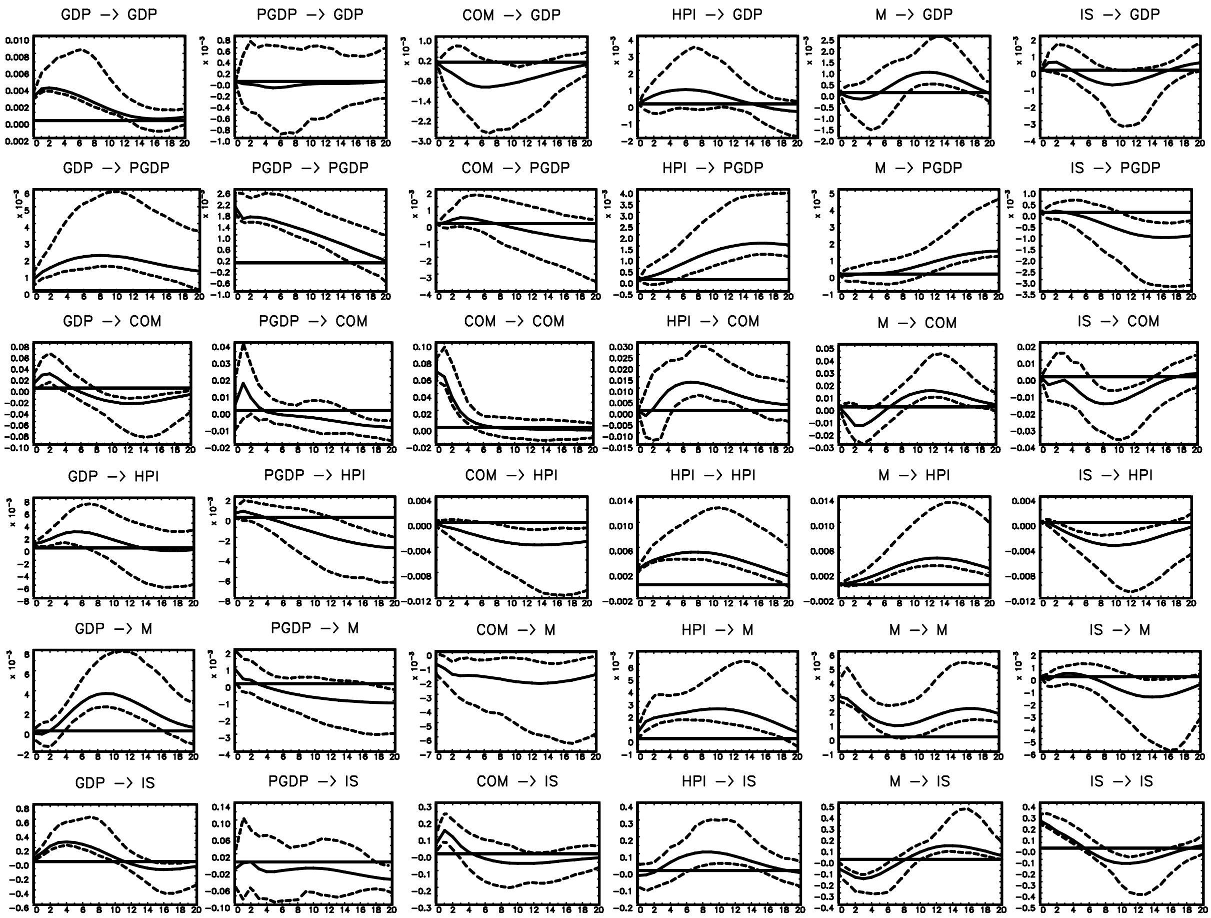
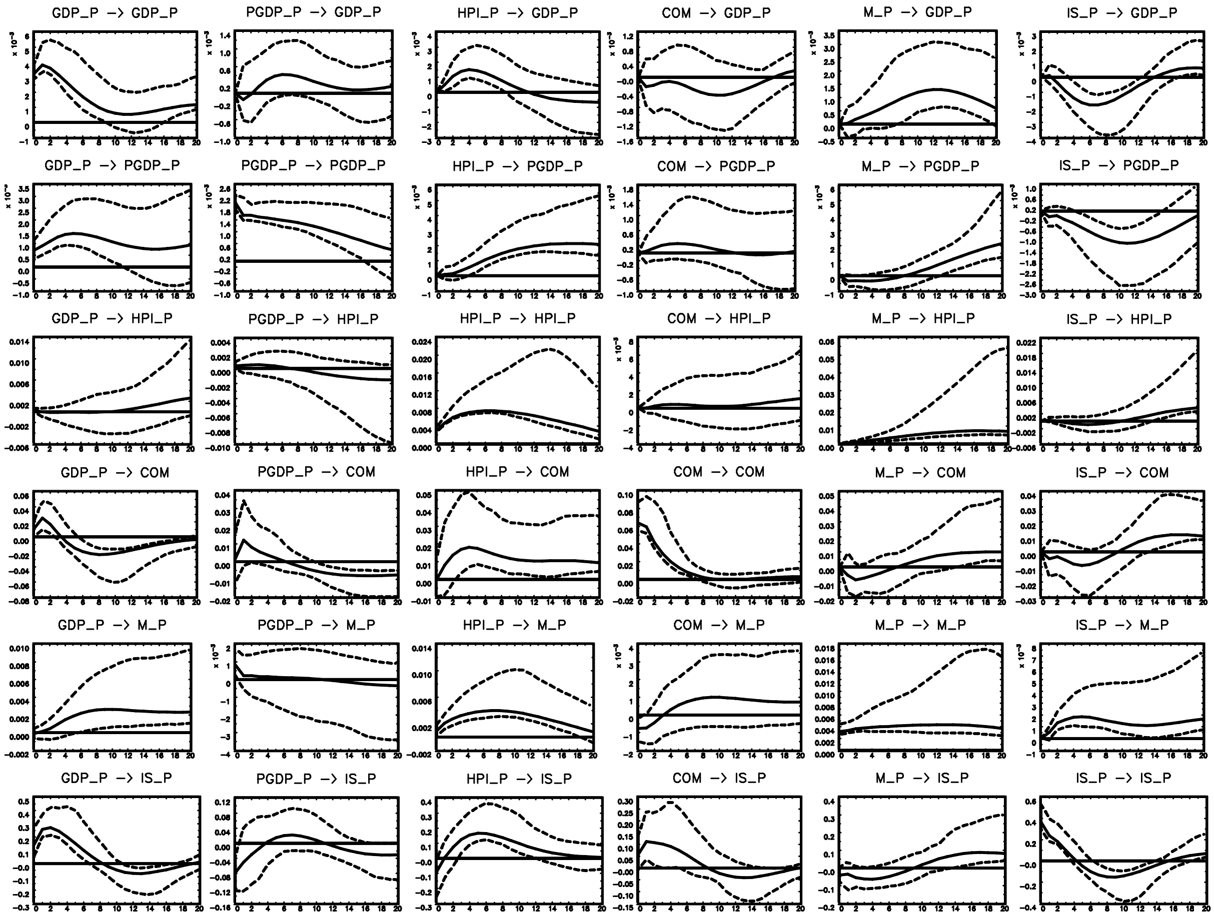


Appendix A1: Impulse responses for benchmark specification, aggregated with market exchange rates.



Appendix A2: Impulse responses for benchmark specification, aggregated with PPP exchange rates.

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