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WHAT IS GLOBAL EXCESS LIQUIDITY, AND DOES IT MATTER?

by Rasmus Rüffer
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In 2006 all ECB publications feature a motif taken from the €5 banknote.

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Abstract

This paper endeavours to provide a comprehensive analysis of the nature and the possible importance of "global excess liquidity", a concept which has attracted considerable attention in recent years. The contribution of this paper is threefold. First, we present some conceptual discussion on the meaning of excess liquidity in advanced countries with developed financial markets. Second, we report some descriptive analysis on the degree of co-movement of several possible measures of excess liquidity and spill-overs between them for a relatively large sample of industrialised and developing countries. Third, we estimate a VAR model for an aggregate of the major industrialised countries and analyse the transmission of shocks to global excess liquidity to the global economy, including possible cross-border spill-over effects to a number of domestic variables in the world's three largest economies (the US, the euro area and Japan).

Keywords: Global excess liquidity, monetary policy, open economy, international economics.

JEL classification codes: E52, F42

Non-technical summary

Over recent years, market participants and economic analysts (including policy-making institutions such as the BIS and the ECB) have repeatedly expressed concerns about the excessive accumulation of liquidity in the world economy, especially in relation to its possible implications for price and financial stability at a global level. Concerns about the impact on asset prices, in particular, have been repeatedly voiced.

Measuring excess liquidity is not a straightforward matter, however, especially in modern financial systems in which central bank-created (i.e. "outside"), high-powered money often represents only a tiny fraction of monetary and credit aggregates which are normally considered relevant for explaining aggregate demand. Some observers thus propose to compare broad, i.e. "inside" monetary aggregates with nominal spending at a global level, and to analyse the behaviour and effects of the resulting gap, i.e. **global excess liquidity**.

The contribution of this paper to this policy debate is threefold:

- **First**, we endeavour to provide some **conceptual analysis** of the meaning of "excess liquidity" in a world of developed financial markets, where any relevant definition of liquidity cannot be related to central bank-driven injections of high-powered money, but rather reflects the endogenous choice of households and firms (*endogenous* money). Moreover, we provide a brief survey of the existing literature on the *cross-border transmission of monetary shocks*, both theoretical and empirical, in order to shed some light on the possible channels though which shocks to excess liquidity could be transmitted across borders.
- **Second**, we collect data on several measures of excess liquidity for a relatively large number of industrialised and developing countries and we analyse the **co-movement** across them by means of a dynamic factor analysis. However, more than in the co-movement in this paper we are focused on studying the possible *cross-country spill-over* of excess liquidity. Therefore, we also analyse whether the common dynamic factor – which we interpret as a measure of "global excess liquidity" – Granger-causes excess liquidity and nominal spending (measured by nominal GDP) in individual countries.
- **Third**, we estimate a **global VAR model** including a measure of global liquidity, proxied by a broad monetary aggregate in the G5 countries (Canada, euro area, Japan, United Kingdom and United States), 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 some domestic variables for the world's three largest economies, the US, the euro area and

Japan. In particular, we analyse the impact of a *shock* to global excess liquidity on a number of domestic 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 main conclusions of the study 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 a "spectrum of yields") which matter for aggregate demand and hence inflation. Thus we conclude that **excess liquidity is a useful indicator of inflationary pressure at a global level** and therefore merits some attention in the same way as the level of interest rates, if not possibly more.
- At the same time, the channels though which excess liquidity might be transmitted across borders are both theoretically ambiguous and empirically rather elusive. By means of a Granger causality analysis we are able to find only scattered evidence of cross-border transmission. However, the VAR analysis (thanks to the sharper focus of the structural approach) is able to find evidence of a **significant spill-over of global liquidity to the euro area economy and to a lesser extent to Japan**, which is in line with the existing empirical literature suggesting that foreign monetary shocks have an **expansionary effect**.
- It is also interesting to note that the impact of global excess liquidity **on the US economy** is found to be significantly **more limited** and less straightforward to explain. It appears that global liquidity plays a different and more limited role for the "leader" currency in the international monetary system. This is an issue which might be worth taking up in future research.

1. Introduction

Over recent years, market participants and economic analysts (including policy-making institutions such as the BIS and the ECB) have repeatedly expressed concerns about the excessive accumulation of liquidity in the world economy, especially in relation to its possible implications for price and financial stability at a global level. Concerns about the impact on asset prices, in particular, have been repeatedly voiced.

Mervyn King, the Governor of the Bank of England, said for example in a recent speech (King, 2006) that *"rapid growth of money – as central banks have kept official interest rates very low – has helped to push up asset prices as investors search for yield. Data from the IMF suggest that world broad money in 2004 and 2005 was growing at its fastest rate since the late 1980s."* Similar concerns have surfaced in the financial press. For example, the Economist of 11 August 2005 reads: *" … global liquidity has expanded at its fastest pace for three decades. If you flood the world with money, it has to go somewhere, and some of it has gone into bonds, resulting in lower yields."*.

Measuring excess liquidity is not a straightforward matter, however, especially in modern financial systems in which central bank-created (i.e. "outside"), high-powered money often represents only a tiny fraction of monetary and credit aggregates which are normally considered relevant for explaining aggregate demand. For that reason it is often proposed to compare broad, i.e. "inside" monetary aggregates with nominal spending: "*While the concept of excess liquidity sounds intuitive, its measurement is fraught with difficulties. What exactly is liquidity, and how do we determine whether it is excessive or not? I usually define excess liquidity as the ratio of a monetary aggregate to nominal GDP, a.k.a. the 'Marshallian K', which is equivalent to the inverse of the 'velocity of money'*." Looking at the most recent data available at the time, the conclusion is that *"global excess liquidity is alive and kicking, read: still expanding" (Morgan Stanley, 2005).*

Against the background of this debate, the contribution of this paper is threefold. First, we endeavour to provide some conceptual analysis of the meaning of "excess liquidity" in a world of developed financial markets, where any relevant definition of liquidity cannot be related to central bank-driven injections of high-powered money, but rather reflects the endogenous choice of households and firms ("endogenous" money).[3] Moreover, we provide a brief survey of the existing literature on the cross-border transmission of monetary shocks,

[3] See for example Laidler (1999) and Pösö and Stracca (2004) for more discussion on the distinction between inside and outside money.

both theoretical and empirical, in order to shed some light on the possible channels through which shocks to excess liquidity could be transmitted across borders.

Second, we assess empirically whether excess liquidity measures in individual countries exhibit significant co-movement and whether excess liquidity conditions spills over across borders. In an initial step, we try to gain some understanding of the extent to which excess liquidity and its spill-overs may be a global phenomenon by including a relatively large number of countries. The price that we have to pay for the broader country coverage is, however, that data limitations for many – especially emerging market – economies pose some constraints on the analysis. Therefore, we focus on various measures of excess liquidity only and study the co-movement across them by means of a dynamic factor analysis. Possibly more importantly, we use the same measures of excess liquidity to study the extent of *cross-country spill-overs* caused by excess liquidity. Therefore, we also analyse whether the common dynamic factor – which we interpret as a measure of "global excess liquidity" – Granger-causes excess liquidity and nominal spending (measured by nominal GDP) in individual countries.

Third, we study the relevance of excess liquidity and cross-country liquidity spill-overs in more depth for the smaller set of G5 countries (Canada, euro area, Japan, United Kingdom and United States) for which better quality data are available. Similar to Sousa and Zaghini (2003) we estimate a global VAR model including a measure of global liquidity in order to identify the impact of a shock to excess liquidity on output and prices at the level of the world economy. In this set-up we proxy global excess liquidity by an aggregation of broad money in the G5 countries unadjusted for nominal GDP, since we include prices and output separately in the specification. This allows us to interpret a shock to excess liquidity since the endogenous response of money to income and prices is already taken into account., For the aggregate G5 model, we find that our measure of excess liquidity has a statistically significant and sizeable impact on output and prices at a global level. While this result underlines the potential usefulness of the concept of global excess liquidity, it, however, does not allow us to distinguish whether what we observe at a global level is due to the simple aggregation of the impacts in the individual economies or, at least to some extent, also to a spill-over across countries. Hence, in a further step of the analysis we extend the global VAR model by including some domestic variables for the world's three largest economies, the US, the euro area and Japan.

Unlike Sousa and Zaghini, we follow a "marginal approach" similar to Kim (2001) and analyse the impact of a *shock* to global excess liquidity on a number of domestic 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.

Our paper is related to some recent contributions in the literature which have found evidence that global inflationary pressure appears to be an important, if not the most important, determinant of inflationary pressure at a global level (see for example Ciccarelli and Mojon 2005). Notably, Borio and Filardo (2006) have recently argued that a global measure of the output gap outperforms domestic measures in affecting inflationary pressure in 15 industrialised countries. Our paper endeavours to shed some light on the issue of whether this is also true for the monetary shocks, which is important since these shocks arguably drive the long-term developments in inflation at a global level.

The paper is structured as follows. In Section 2 we discuss the conceptual underpinnings of excess liquidity and of its possible cross-country transmission. In Section 3 we describe the data used in our analysis and we analyse the comovement across excess liquidity indicators for each country and carry out the Granger causality analysis. The VAR analysis is in Section 4. Section 5 concludes.

2. Is it useful to look at global excess liquidity and at cross-country liquidity spillovers?

In this section we set out to shed some light on the nature and possible importance of global excess liquidity at a conceptual level. We divide the discussion in two parts. In Section 2.1, we propose an interpretation of quantitative measures of excess liquidity as indicators of inflationary pressure and hence, broadly speaking, of the monetary policy stance. In Section 2.2, we provide a brief survey of the literature on the cross-border transmission of monetary shocks in the traditional Mundell-Fleming framework as well as in modern open economy models featuring nominal rigidities. The basic question we attempt to answer is whether the indications coming from this literature – where a monetary shock is typically a central bank-led change in the monetary base or, interchangeably, in the a money market interest rate – carry through also to a situation where "money" is measured by an endogenous, private sector-chosen broad monetary aggregate.

2.1 Excess money as an indicator of inflationary pressure

In a perfectly functioning, frictionless capital market, purchasing power is transferred across time and contingencies at no cost and asset prices and returns are sufficient statistic for all the market information. In such a world, measures of the money supply (and more generally financial quantities) contain no independent information, since a nominal risk-free interest rate summarises all the information which is relevant for the equilibrium in the money market. Hence, any measure of excess liquidity derived from the deviation of some monetary aggregate from a normative value would provide little or no additional information (Svensson, 2003).

However, there is a long tradition of economic thought, which goes back to the "founding fathers" of monetarism (Milton Friedman, Anna Schwartz, Karl Brunner, Allan Meltzer and so on) emphasising that, due to a number of capital market imperfections, money and non-monetary assets may be imperfectly substitutable. As a consequence, the behaviour of monetary aggregates may reflect not only contemporaneous output, price and interest rate developments, but also a "spectrum of yields" on a number of financial and real assets. To the extent that this is the case, then "excess liquidity" – defined operationally as money demand purged from, and not explainable by, the influence of current nominal spending and of a short-term interest rate – may be a proxy variable for yields which matter for aggregate demand and inflationary pressure.[4]

In the continuation, we are going to build on the hypothesis that a measure of excess money may have information on inflationary pressure. It should be noted that pressures on aggregate demand may stem from a number of demand and supply shocks that are not necessarily related to shocks in the supply of money by the central bank. Nonetheless, a broad interpretation of a money-based measure of inflationary pressure in terms of "monetary policy stance" is a legitimate one, if one is ready to accept that the ultimate responsibility for inflationary pressure lies in the management of nominal aggregate demand and thus squarely with the monetary authority. This is consistent with a view of inflation and the price level in which the central bank can decide to accommodate, or not accommodate, inflationary pressures coming from a variety of economic actors and phenomena, as pioneered by Gordon (1975).[5] Our focus on this paper is whether monetary aggregates can capture the thrust of these shocks at a global level, in a world of developed financial systems in which monetary policy is carried out in a complex game of credibility and expectations and cannot be easily measured by observing a rate of growth of base money or the level of the overnight rate. Our second question of interest is whether global monetary shocks (seen as shocks to the "demand" for domestic inflation) affect macroeconomic variables in large-sized economies, where monetary authorities arguably pursue an independent monetary policy.

4 See Meltzer (1999) and Nelson (2003) for an extended exposition of this argument.

5 See, for example, this quotation from Gordon (1975): "While no group in society explicitly "demands" more inflation, pressures for the government to pursue a more inflationary policy, or not to pursue an anti-inflationary policy, emanate from taxpayers who resist tax increases (...) groups attempting to obtain an increase in their share of national income and, <u>in open economies, from price increases and inflows of money from abroad</u>. These pressures constitute an implicit, if not an explicit, demand for inflation. (…) The mere existence of pressures on the government to inflate does not guarantee that inflation will occur. Variations in the monetary expansion "supplied" in response to a given level of pressure must be explained as well."

If this interpretation that excess money contains information on inflationary pressure is correct (as indeed also argued by Meltzer 1999 and Nelson 2003) then the type of shocks which excess liquidity may proxy for is not essentially different from an injection of outside money in the economy normally studied in the literature, which is typically thought to result in a *persistent* rise of nominal aggregate demand and a *temporary* rise of real economic activity. This implies, in turn, that we can use the existing literature on the international transmission of monetary policy shocks as a guideline for the analysis of excess liqudity spill-overs. We turn to briefly survey this literature in the next section.

2.2 The international transmission of monetary shocks: a relevant framework for excess liquidity spillovers?

2.2.1 What should we expect in theory?

The Mundell-Fleming framework. An important framework for earlier thinking about international monetary transmission was the Mundell-Fleming (MF) model.[6] An expansionary monetary policy shock, which is represented by a central bank-induced increase in the supply of money, leads to a reduction of the domestic interest rate, which, in turn, triggers a depreciation of the home currency through the resulting capital outflows. As a result, global spending is directed towards domestic goods and domestic output increases (*expenditure-switching effect*). The impact of monetary policy is of the "beggar-thy-neighbour" type, raising domestic output at the expense of foreign output.[7] As money is an exogenous variable, no direct quantity spill-overs of liquidity occur.[8] However, it remains possible that the foreign monetary authority reacts to the contraction of foreign output by injecting more money into the system. The reaction of the foreign monetary authority may thus create a positive correlation between domestic money and foreign money, while weakening at the same time the correlation between domestic monetary policy and foreign output.

The New Open Economy Models. In the new generation of models (see e.g. Obstfeld and Rogoff 1995, Kollmann 2001) featuring nominal rigidities and imperfect asset substitution

[6] The discussion is limited to the case of flexible exchange rates. In the case of fixed exchange rates the spillover operates directly through the monetary policy reaction of the other country, which is completely determined by the desire to keep the exchange rate fixed. In reality, many nominally flexible exchange rate regimes may contain elements of a fixed rate regime, for instance, due to a "fear of floating". Observed spillovers may therefore reflect at least in part an endogenous monetary policy response even in the case of "official floaters".

[7] The impact on output should not be confused with the impact on real disposable income and consumption, since the depreciation of the exchange rate worsens the terms of trade for the home country. As shown by Tille (2001), if home and foreign goods are poor substitutes, a country can be adversely affected by its own monetary expansion because of the worsening of the terms of trade.

[8] In Annex 1 we sketch a portfolio balance model similar to Branson (1977), which can be used to think more formally of the transmission of monetary policy shocks when monetary aggregates are endogenous.

across countries[9] the basic MF result may be overturned and expansionary monetary policy increases output *both* at home and abroad ("prosper-thy-neighbor" effect). As in the MF model, the home currency depreciates as a result of the monetary expansion, which leads to a demand shift away from foreign goods. However, this intra-temporal effect may be overturned by the inter-temporal effect as initially sticky prices are expected to increase in the following period, thereby reducing the real rate of interest on foreign assets. As current period goods thus become cheaper relative to future goods, demand – both for foreign and domestic goods – is at the same time shifted towards the present (*intertemporal switching effect*). If this intertemporal aspect, which is completely absent in the MF framework, prevails a domestic monetary expansion raises foreign output.

In addition, the expenditure-switching effect is significantly reduced if firms follow pricing to market policies, i.e. set prices in the local, rather than the domestic currency in order to maintain market share (Betts and Devereux 2001, Schmidt 2006). Also in this framework, the endogenous reaction of foreign monetary policy to foreign consumer prices, which are affected by exchange rate developments, may undo the expenditure switching effect and affect the correlation between the domestic policy impulse and foreign output (Borondo 2000). The same could be said, however, of the intertemporal switching effect, whose impact could *also* be undone by the monetary authorities in the foreign country. Hence, it can be concluded that the effect of a domestic monetary policy shock, which is transmitted through exchange rate and interest rate effects, on foreign output is ambiguous, especially when the (endogenous) reaction of foreign monetary policy is contemplated.[10]

Direct transmission of price shocks. Another channel of transmission, which has been described in the literature, does not require any spill-over of aggregate demand conditions across countries, but affects the foreign economy directly through a cost-push shock. The argument is that, if foreign prices rise and if such rise is not compensated by an appreciation of the exchange rate, this increases firms' marginal costs directly (through trade in intermediate products) as well as indirectly (through the impact of higher import prices on workers' purchasing power and therefore on wage demands). Changes in marginal costs are then transmitted to inflation (Kollmann 2001). Depending on the extent to which domestic inflationary pressures are accommodated or not by the central bank, a foreign expansionary monetary shock can raise the domestic price level more or less permanently.

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[9] See Lane (2001) for a survey of this literature.

[10] Even if an expansionary domestic monetary policy shock decreases foreign output, both foreign and domestic welfare increase nonetheless. Those effects leading to a welfare reduction turn out to be second-order effects, with the only first-order effect being the reduction in monopolistic distortions brought about be a monetary expansion, which is unambiguously welfare improving.

2.2.2 What does the existing empirical work suggest?

On the empirical side, a number of studies have tried to identify the transmission of monetary and/or liquidity conditions across countries. Most of these studies focus on the transmission of monetary policy shocks in the framework of a VAR model. It is important to note that the existing empirical analysis typically limit the analysis to the impact of a monetary policy shock from the "leader" country (i.e. the US) on "follower" countries that have at least some features of small open economies. The empirical literature is very scarce on the transmission of monetary shocks among equally-sized countries.

Using a VAR set-up to analyse data for the G7 countries, Kim (2001) finds that, in contrast to the basic prediction of the Mundell-Fleming model, an expansionary US monetary policy shock leads to an increase in activity both in the US and in other countries. US monetary policy, through lowering world real interest rates, stimulates aggregate demand globally. Although the US trade balance also improves after some time, the magnitude of this effect appears to be too small to validate the Mundell-Fleming predictions. In addition to the federal funds rate, Kim also includes various monetary aggregates individually (non-borrowed reserves, overall reserves, M0, M1, and M2) in the VAR and finds that the results are generally robust to their inclusion. Betts and Deveraux (2001) and Miniane and Rogers (2003) also provide evidence for a positive transmission effect of US expansionary monetary policy shocks on output in other countries. Ehrmann and Fratzscher (2006) document significant effects of US monetary policy shocks on equity market developments in a large number of countries.

Further evidence on the importance of cross-country spill-over effects comes from Canova (2005), who studies the transmission of US shocks to eight Latin American countries, using a Bayesian VAR. An important finding of this paper is that a US monetary shock (as opposed to other US shocks) has a strong impact on macroeconomic developments in these countries. However, the patterns of transmission are somewhat different from those typically found in developed countries. After a contractionary US monetary policy shock, interest rates are found to rise, which attracts capital inflows and pushes aggregate demand up, not down.

It should be noted that there is typically no analysis of the impact of foreign monetary shocks *on US variables* in this literature. One way in which we aim at contributing to the literature is to take a global perspective and analyse not only the impact of US monetary shocks on other countries, but also the impact of global monetary shocks onto the US, i.e. the "reserve country".

The second contribution of our empirical analysis compared with the existing literature is to look at a quantity-based measure of the monetary policy stance, while in the literature monetary policy is mainly captured by nominal short-term interest rates. The existing empirical work using quantity-based measures, such as monetary aggregates, is in fact quite scant. Baks and Kramer (1999) document that aggregate G7 money growth appears to have some effect on G-7 interest rates and stock returns. Moreover, they also evaluate the extent of the cross-country spillover, finding that increased liquidity growth in one country is often consistent with an increase in G-7 real stock returns and a decline in real interest rates in other countries. (In particular this is true for the transmission from Japan to the US). Baks and Kramer look at "excess" money growth, obtained subtracting nominal GDP growth from nominal money growth. In line with Schinasi and Hargraves (1993), they interpret this measure as "potential inflation pressures in markets not captured by national income account measure of output and prices".

Sousa and Zaghini (2003) include a "global liquidity" variable in a VAR model of the euro area in order to analyse whether monetary aggregates in the euro area are affected by liquidity developments abroad. The global liquidity indicator is constructed aggregating broad money indicators for the US, Japan, the UK and Canada. They find that a positive shock to these liquidity aggregates results in an increase in euro area prices, output and in the monetary aggregate M3. Moreover, in the variance decomposition analysis they find that the bulk of the variability of euro area M3 and the price level is determined by fluctuations in global liquidity. Holman and Neumann (2002) analyse the transmission of monetary shocks between the US and Canada. Using a VAR specification including monetary aggregates in both countries but no interest rates, they find significant spill-overs to the other country's real sector. At the same time, a monetary expansion in one country leads to a slight and statistically insignificant monetary contraction in the partner country.

3. An analysis of cross-country liquidity spillovers

3.1 The data

In this study we gather data for 15 countries, including the euro area, United States of America, Japan, United Kingdom, Canada, China, India, Korea, Thailand, Taiwan, Brazil, Mexico, Australia, New Zealand, and South Africa. For each country, we collect a measure of narrow and broad money stock, seasonally adjusted where possible (otherwise seasonally adjusted by applying the X12-ARIMA procedure) and nominal GDP (again seasonally adjusted with X-12 where needed). We can then compute the "excess money" indicator for each country as a ratio between broad or narrow money and nominal GDP; this measure is computed both for broad and narrow money. It should be noted that, at this stage, we are not controlling for the influence of changes in the short-term interest rate and we are also imposing a unit coefficient on nominal GDP, which might not hold in practice. Hence, the proposed measure of excess liquidity is a relatively rough one and should only be interpreted as a starting point in the analysis. We will propose a more elaborated and probably more realistic measure in the VAR analysis in the next Section.

The data are collected at a quarterly frequency, over a sample period from 1980Q1 to 2004 Q4 (but data for most countries, especially developing ones, are available only on a considerably shorter sample). Data sources differ across variables and countries; they include the ECB, the BIS, IMF, OECD, Eurostat and CEIC databases. For broad and narrow money, national definitions have been used.[11]

For a subset of countries for which more data are available, namely the G5 countries (US, euro area, Japan, Canada and United Kingdom) we have collected a larger database.[12] Besides the excess money indicators, for each of these economic areas the database includes the log of real GDP, the log of the GDP deflator, a short-term (3-month) nominal interbank interest rate, the log of the real effective exchange rate, and the log of an index of real asset prices, including residential and commercial property and equity prices.[13]

We also build global aggregates in a way similar to Sousa and Zaghini (2003, 2006) by aggregating the variables for the G5 countries. The cross-country aggregation is carried out by using fixed real GDP weights at PPP exchange rates of 1995 (which is at about the middle of our sample period), using IMF data.

Moreover, for the world's three largest economies (the US, the euro area and Japan) we construct a measure of external monetary conditions, i.e. the monetary conditions prevailing globally excluding domestic developments. These conditions are proxied by aggregate broad money in the G5 with the exclusion of one among US or the euro area or Japan each time. Thus, for example the relevant G4 aggregate for the euro area is the aggregate excess money in the G5 with the exclusion of the US component, and thus represents an indicator of external broad liquidity conditions relevant for the euro area (in this dimension we also follow the same approach as in Sousa and Zaghini, 2003). In addition, we model other aspects of the external environment by aggregating real GDP and the GDP deflator for the G4 countries.

For illustrative purposes, **Figure 1** reports the four key variables we are going to analyse (real GDP, the GDP deflator, excess money and the nominal interest rate) for the G5. It is

[11] Note that our data do not cover cross-border deposits.

[12] It should be noted that the G5 countries represent over half of the world economy in real GDP evaluated at PPP exchange rates, and close of 90% of the advanced economies. Although we do not have data, it is very likely that their weight on the world economy is much larger than 50% as far as monetary and financial aggregates are concerned, due to the higher degree of financial development in the advanced countries.

[13] The latter data have been kindly provided by C. Borio at the Bank for International Settlements; see Borio and Lowe (2002) for an application of these data. The aggregate index for the euro area is based

interesting to note the sharp rise in the excess money variable since 2000, a phenomenon which, in conjunction with the very low level of interest rates, has attracted a lot of attention in "excess liquidity" in the world economy. At the same time, the shortfall of money in the second half of the 1990s is also noteworthy, although it has attracted much less attention at a global level.

[Insert Figure 1 here]

3.2 A dynamic factor analysis

As a first step in the analysis, we try to obtain a general understanding of the importance of excess liquidity and spill-overs thereof for a relatively broad set of countries, including both industrialised and emerging countries. This broad country coverage, of course, imposes some restrictions on the type of analysis we conduct given data constraints, especially in the case of some emerging market economies. Therefore we limit this preliminary analysis to a study of excess liquidity measures, which can be constructed for all countries in the sample. In this section we assess whether excess liquidity developments in individual countries contain some common "global' component, which might be captured by an unobservable common dynamic factor. Concretely, the following parametric model is estimated:

$$Y_t = AY_{t-1} + BZ_t + \varepsilon_t$$
$$Z_t = DZ_{t-1} + \eta_t$$

Y_t represents the vector of excess liquidity measures in the different countries. Each monetary aggregate is assumed to be a linear function of its own lagged value, an unobservable common component, Z_t, and a white noise error term ε_t. The common factor Z_t, in turn, follows itself a first-order autoregressive process with white noise error term η, whose variance is standardised to unity.[14] To the extent that liquidity conditions in one country spill over to liquidity conditions in other countries this should, in principle, be picked up by this

on the 8 euro area countries for which data are available, which cover more than 90% of the entire euro area.

[14] The addition of further lags did, in general, not improve the fit of the model sufficiently as to justify the associated loss in degrees of freedom. In that respect it is important to note that the effect of the common shock on Y_t is more complex than suggested by the simple AR(1) structure of the common factor, since the common factor also enters the measurement equation through the lagged dependent variable term. In fact, by re-writing the model slightly, it can be seen that it represents a special case of a more general dynamic factor model:

$$Y_t = (I - AL)^{-1} B(I - DL)^{-1} \eta_t + (1 - AL)^{-1} \varepsilon_t$$

dynamic factor specification. However, rather than being evidence of spill-over effects a common factor could also reflect common "global" shocks affecting different countries at the same time rather than true spillovers. The parametric specification allows to separate these two possibilities to some extent, as lagged spill-over effects can be captured by the A matrix, leaving only common shocks to be captured by the common factor.[15]

Initially, we estimate the dynamic factor model for a large set of countries.[16] In order to make the series stationary we employ three different methods of detrending: first order differencing, detrending with a linear time trend and de-trending using an HP-filter. In each case we consider both narrow and broad monetary aggregates.

The results, reported in **Table 1**, suggest that the degree of co-movements differs significantly between the different methods of detrending, while the distinction between narrow and broad money appears to be generally less important. The highest degree of co-movement is found for time-detrended variables and the lowest for differenced aggregates. In the former case, the common factor explains on average around one third of the variance of a country's monetary aggregates. As the share of variance explained by the common factor is generally highest for the main industrialised countries we re-estimated the model for the G7 (including the euro area) countries only. As a result, the average share of variance explained by the common factor increases in almost all cases, with particularly strong increases in the case of time de-trended data, where the share increases to about 50% in the case of narrow money. In general, no clear pattern emerges regarding possible country groupings within the G7 with particularly strong links. A possibly argument could be made that the common factor is especially important in the case of the US (though not for narrow money) and Canada, suggesting that spillovers from the US might be especially important in driving monetary developments in the G7 with the effect on neighbouring Canada being particularly strong.

[Insert Table 1 here]

[15] Unfortunately, such a separation of effects is not completely possible to the extent that some spill-overs occur within the same period rather than with a lag, which appears likely given the quarterly frequency of the data. For a more detailed discussion of the above specification of the dynamic factor model see Monfort et al. (2003).

[16] We chose to exclude some countries from the entire sample as limited sample sizes in some cases would have been too costly in terms of degrees of freedom. Ultimately, the factor analysis includes the euro area, United States, Japan, United Kingdom, Canada, Korea, Taiwan, Mexico, Australia and South Africa.

3.3 Granger-causality analysis

While the common factor analysis has the advantage of being multi-variate in nature, allowing the simultaneous analysis of a large number of time series, it may fail under certain circumstances to provide evidence for actual spill-over effects, as opposed to common shocks driving the variables. Thus, in order to complement the preceding analysis we therefore perform Granger-causality tests for the various monetary aggregates in different countries.

Along similar lines, Baks and Kramer (1999) also conduct Granger-causality for different monetary aggregates of the G7 countries and find strong evidence that US and Japanese broad money growth Granger-causes broad money growth abroad, with little evidence of causality in the case of German money. No causality is found for narrow aggregates, however.

Our own analysis[17] (not reported in full for brevity) suggests that there is some limited evidence for statistically significant causation between the excess liquidity measures in different countries. In general, causation is found more frequently for liquidity measures based on narrow money than for those based on broad aggregates. Among the various excess liquidity measures, it is in particular the time-detrended measures followed by the HP-filtered and the differenced aggregate.[18] A considerable number of cases of significant causation involve the major industrialised countries (about one third of the overall number). However, most of that causation is towards countries outside the group with only limited causation between the industrialised countries themselves. Liquidity conditions in the United States appear to be especially important, followed by the euro area, the United Kingdom and, last, Japan.

Applying a gravity-type argument to the geographical distribution of liquidity spill-overs, one might expect that the transmission of liquidity conditions exhibits a strong regional component. Nonetheless, the data do not appear to support such a conclusion. For example, the causation from the US or Japan does not exhibit any tendency to be particularly pronounced in the Western Hemisphere and Asia, respectively.

Some cases of Granger-causation can also be found in the case of the common factor extracted from the various measures of excess liquidity across different countries (see **Table 2**). The results for the common factor calculated for the five major industrialised countries and that for the wider group including five additional countries (Australia, Korea, Mexico, South Africa, Taiwan) are very similar and we report only those for the former (see table below). Overall, it seems again that causation is more often found for narrow monetary

[17] In the Granger-causality test we allow for four lags.

[18] In principle, we could have also performed the Granger-causality tests for the non-adjusted excess liquidity measures, i.e. without applying any de-trending procedure. However, since these are likely to

aggregates. For example, in the case of the euro area, shown in the first row of Table 2, the effect of the common excess liquidity factor on the domestic money aggregate is larger and more significant in the case of differenced and time de-trended broad money, but in no case significant for narrow money. Causation is also more frequent for the major five industrialised countries.[19] Some evidence can be found that monetary conditions in Korea, Brazil and New Zealand might be affected by developments in the five major industrialised countries. The evidence is, however, in general not robust to the definition of the monetary aggregate. These results are consistent with earlier evidence (for example see Mishkin 2005) that the bulk of cross-border financial flows take place among advanced countries, which are significantly more financially integrated than emerging economies.

[Insert Table 2 here]

In addition to testing for Granger causality between measures of excess money in different countries we also test whether excess money in one country Granger causes nominal GDP growth in other countries. Again, we find some limited evidence for such causation. Also in this case, cross-country spill-overs are particularly frequent for excess money in the major five economic countries/areas, with the effect being predominantly on the GDP of countries outside this group. However, again no clear regional patterns can be identified. Causation from the common factor is most significant in the case of the major five industrialised countries, suggesting a possible link between aggregate liquidity conditions within the group on activity in the group (see Table 2). Activity outside this core group appears to be largely unaffected, however, with the possible exception of Korea and Taiwan.

In order to gauge whether cross-country liquidity spill-over effects have gained in importance over time we also conduct the same Granger-causality tests for the more recent sub-sample starting in the first quarter of 1990 (see **Table 3**). Overall, there appears to be some evidence that liquidity spill-overs might have become, if anything, somewhat less prevalent for the major five industrialised economies. This applies both for spill-overs to liquidity conditions and to nominal GDP. For liquidity spill-overs to other countries no strong tendency of increasing or decreasing importance can be identified.

[Insert Table 3 here]

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be non-stationary this would have potentially given rise to spurious causation (see, for example, He and Maekawa, 2001).

[19] Of course, one limitation of this analysis is that the monetary aggregates of the five major industrialised countries form the basis for the estimation of the common factor. However, although the common factor should therefore capture the main common features of monetary dynamics in these

3.4 Discussion

The above analysis provides some evidence for potential interactions between liquidity conditions in different countries. The common dynamic factor analysis showed that there is a significant degree of co-movement between the various measures of liquidity, especially for the major industrialised countries. Although this co-movement may reflect common shocks, it may also reflect spill-over effects, with the two effects being difficult to disentangle. Some supporting evidence for the spill-over hypothesis comes from the Granger-causality tests, which suggest that, in particular, excess liquidity conditions in the industrialised countries may spill over within the advanced countries and, to a lesser extent, to the "periphery". The evidence for such spill-over effects is, however, in general not particularly strong.

The main difficulty in analysing directly the co-movement/interaction between measures of liquidity conditions is that these are affected by a number of different shocks which may lead to very different interactions between measures across countries. Although an increase in liquidity in one country may by itself lead to an increase in liquidity conditions in other countries, the underlying shocks may affect other variables as well, which may more than offset this positive effect on foreign liquidity. In order to isolate the interaction between liquidity conditions from such interferences originating in other areas of the economy, it is important to broaden the analysis and move towards a more structural approach. In particular, one would have to model the economies involved more explicitly and identify the various shocks driving the entire system. As the above preliminary analysis suggests that excess liquidity may play a particularly important role in the case of the major industrialised countries, for which data constraints are less binding, we concentrate the more in-depth analysis of the shock structure in the next section on the smaller set of G5 countries.

4. A VAR analysis for the US, the euro area and Japan

4.1 A global model

We start by estimating a baseline VAR model including (in a Choleski ordering) the log of real GDP, the log of the GDP deflator, the log of nominal broad money indicator and the nominal short-term interest rate for the G5, i.e. a global model. The sample period for which data are available for all G5 countries is 1981:Q4 to 2004:Q4. A lag order of 3 is chosen, the minimal order which ensures no serial correlation of the residuals. A constant and a linear trend (since the model is specified in log-levels) are added to this VAR model and all subsequent ones estimated in this paper.

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countries, this does not imply any causal relationship between the common factor and individual country monetary aggregates.

Since this is the benchmark specification for our subsequent analysis, we conduct some specification analysis in order to check the properties of the model. The multivariate LM AR test can detect no significant serial correlation up to 4 quarterly lags, and the multivariate Jarque-Bera test suggests that residuals are approximately Normal. We also consider a different, non-recursive identification scheme similar to that proposed by Kim (2001), in which the two alternative measures of the monetary policy stance (excess money and the nominal interest rate) are allowed to interact contemporaneously, but where the nominal interest rate does not react contemporaneously to real GDP and the GDP deflator.[20] The results of this alternative identification scheme were very similar to the baseline analysis, so we do not report them here.

Figure 2 shows the impulse responses to the two proposed measures of monetary policy stance for the G5 aggregates. To ensure comparability, the impulse responses show the effect of a *fall* in the nominal interest rate, i.e. in both cases we are analysing the impact of an *expansionary* monetary policy shock. A striking result visible in Figure 2 is that a shock to excess money has all the features expected of an expansionary monetary policy shock: it increases output temporarily, and the price level permanently (or at least very persistently). A second important result is that when monetary policy is measured with the nominal interest rate we likewise have an expansion in output, but also find a price puzzle, at least in the short term (after several quarters, however, the response of the price level is well behaved). It should be noted that this is not solved by adding an index of commodity prices to the VAR, and is a result which is robust to a large number of alternative specifications of the model. Our conclusion is that excess money appears to be a convincing empirical measure of the monetary policy stance at a global level, and that is has independent information value over and above the nominal short-term interest rate. In obtaining this result, as noted previously, we are consistent with a number of recent contributions in the literature (including, also at a global level, Sousa and Zaghini 2006).

[Insert Figure 2 here]

We also re-estimate the G5 model, in the same specification, using the G4 aggregates excluding each time the US and the euro area in turn. The impulse responses are practically the same as in the G5 model.

[20] See Sims and Zha (1998) for a justification of this assumption.

In addition, we include the real asset price index in a five-variable VAR, putting it last in the Choleski ordering after output, the price level, excess money and the nominal interest rate (putting the asset price before the interest rate does not change the results). The impulse responses of this model are reported in **Figure 3**. It is interesting that the real asset price rises, though only temporarily, following a decline in the nominal interest rate (which is in line with asset pricing theory) but also after a shock to excess liquidity. In the latter case, however, the effect is tiny and not statistically significant, which is a quite interesting result with a view to the discussion about excess liquidity and asset prices mentioned in the Introduction to this paper

Based on the results obtained and motivated by the need to avoid duplications and save on degrees of freedom, we also re-estimate the global VAR models (as well as the extended VAR models in the ensuing section) including *only* excess money as a measure of global monetary policy stance. For illustrative purposes, **Figure 4** reports the impulse responses of G5 output and the price level to a one standard deviation shock in the excess money variable, which again is remarkably consistent with the expected impact of an expansionary monetary policy shock (and in line with the G5 model also including the nominal interest rate). The impact on the real asset price, if included in the model, is also in line with what is reported in Figure 3.

[Insert Figures 3 and 4 here]

4.2 Impact on domestic variables in the US, the euro area and Japan

We now move a step forward and endeavour to analyse the impact of a global expansionary monetary policy shock (measured by a shock to global broad money not explained by global output and price fluctuations) onto domestic variables in the world's three largest economies, the US, the euro area and Japan. For each of the three economies, we estimate the corresponding G4 model (including real GDP, the GDP deflator and broad money) augmented by *five* domestic variables for each economy, i.e. the log of real GDP, the log of the GDP deflator, broad money, the nominal short-term interest rate, and the real effective exchange rate. Thus, an eight-variable VAR model is estimated. The global (G4) variables are put first in the Choleski ordering since they are considered to be "more exogenous" with respect to the domestic variables. Each VAR model is specified with 2 autoregressive lags (one order lower than the G5 model given the bigger size of the model, as signalled by the BIC information criterion) and includes again a constant and a linear trend.[21]

It should be noted that we do not "freeze" the parameters of the G4 models to be the same for the G4 variables in these extended VAR models, and thus we do not impose block exogeneity of the G4 variables vis-à-vis the domestic ones. Our reasoning is that since the US, the euro area and Japan are very large economies, one would like to allow for domestic developments to influence global variables, and in fact block exogeneity tests are rejected for all of them. This approach has the disadvantage that the inclusion of an additional variable in the VAR might hamper the identification of the global monetary shock, which could be a serious problem given the focus of our analysis. In practice, however, we find that the identification of the global monetary shock is maintained, at least in its qualitative features (i.e. implying a temporary upward impact on global output and a more persistent upward impact on the price level).

The differences between our analysis and Sousa and Zaghini (2003) should also be stressed. In that paper, a measure of global money is included in a VAR otherwise comprising only domestic variables. This complicates the interpretation of their findings about the impact of a shock to this variable, since money can respond to a number of different shocks, and in particular to global output and price developments. In this analysis we have a different focus, since we are analysing the impact of an excess money *shock* on domestic variables. The different focus of the analysis will be reflected in a significant different outcome of the variance decomposition analysis, as will be shown below.

The impulse responses to a one standard deviation shock to global excess liquidity are reported in **Figure 5** (for the US), **Figure 6** (for the euro area) and **Figure 7** (for Japan). We first report the impulse responses of the global (G4) output and the price level to a shock to global excess liquidity. This serves the important purpose of controlling that the extended specification of the VAR models maintains the identification of the shock as an expansionary monetary shock, finding broad confirmation in all cases.

Moving to the impact on domestic variables, which is the main objective of the analysis, we find that the impact of the shock on output is *positive* and significant in the euro area and Japan, while it is *negatively* signed in the US. The most interesting difference is arguably the impact on broad money, which is positive and significant in the euro area but initially statistically insignificant and then negatively signed in the US. In other words, the US appears either to be relatively insulated from the global liquidity shock or to actively counter it, while

[21] It should be noted that in each equation a total of 18 free parameters are estimated, since the VAR models include two autoregressive lags plus a constant and a linear trend. As we have almost 100 quarterly observations in our data, this is considered to be enough to ensure sufficient degrees of freedom in the estimation.

the euro area and Japan appear to be affected by it. Nonetheless, this difference in reaction cannot be explained by the behaviour of monetary policy as captured by a nominal short-term interest rate, since the interest goes *up*, now down, in the euro area and Japan (albeit with some delay), thus offsetting the expansionary shock to some extent, while it does not move (at least in a statistically significant manner) in the US. If one is instead ready to accept that the behaviour of broad money can be a better indicator of the stance of monetary policy, as argued in the previous section, then the impulse responses seem to fit with the story that the US monetary authority insulates the US economy from the global monetary shock, while the monetary authorities in Japan and euro area allow it to be transmitted to domestic monetary conditions (and hence output and prices).

Overall, the impact on the euro area economy is relatively easy to interpret and presents a textbook combination of Mundell-Fleming and New Open Economy effects. The Mundell-Fleming channel is visible in the appreciation of the real effective exchange rate. This effect, however, is dominated by an inter-temporal substitution effect which is clearly visible in the rise of excess liquidity (proxy for the "spectrum of yields"). This leads to an expansion of economic activity, which can be seen in the rise of real GDP. Despite the appreciation of the exchange rate, the price level rises, in line with the rise in demand and also possibly reflecting a direct spill-over from global price developments, e.g. through import prices. It is interesting to note that, when estimated the same model on a small open economy like Canada (reported in **Figure 8**), we get very similar results as in the euro area, with the exception that in this case the nominal interest rate *falls* after the shock, rather than rising.

The results for Japan are quite similar to the euro area, but with a lesser degree of clarity in particular as regards the reaction of the price level, which displays a significant price *decline* several quarters after the shock, before rising again thereafter. This could be explained in part by the consideration that Japan is a considerably closer economy compared with the euro area, which is significantly more open. Moreover, the peculiar development of the price level (and of the nominal interest rate) in Japan from the early 1990s suggests that there could be non-linearities in the model (as it is, in fact, signalled by the multivariate Jarque-Bera tests for Normality of the residuals), possibly related to the policy of quantitative easing. These non-linearities are obviously not captured in the linear model, and which therefore suggest some caution in over-interpreting its results.

By contrast, it is more difficult to interpret the US findings. There, we observe a lack of reaction of excess liquidity, which may reflect a weaker inter-temporal substitution effect stemming from non-US developments or the presence of an active policy of countering external shocks (in line with the idea of an economic and financial dominance of the US in the world economy). Hence, real GDP does not rise. The only noticeable impact we observe is on the US price level, which increases after the shock despite the lack of a positive spill-over on economic activity, which again could be explained by the direct impact of price developments abroad (a cost-push type of channel). Overall, the US appears to be much more "insulated" from the global liquidity shock than the euro area, as will be also visible later in the variance decomposition analysis.

The main findings for the three economies are qualitatively robust to some changes in the specification of the VAR models which we have attempted, such as in the ordering of the variables. Moreover, we tried to include the domestic real asset price index in place of the real effective exchange rate (see **Figure 9**). Also in this case, the results for the euro area and Japan are easier to interpret, since we find a statistically significant *rise* in the asset price (consistent with the overall expansionary impact of the global liquidity shock). In the US, by contrast, we observe a slight (but statistically insignificant) *fall* in asset prices, consistent with a lack of a positive reaction of excess liquidity and of economic activity identified in the baseline specification. The other main results of the analysis are unaffected by this modification.

Motivated by the exceptional recent interest in the US balance of payments deficit and its contribution to the build up of "global imbalances", we also estimate a variant of the baseline model including the current account of the balance of payments in place of the real effective exchange rate. It is interesting to note that the global monetary shock does not appear to have an impact on the current account in the euro area and Japan, but has a statistically significant and *positive* impact in the US. Hence, we find that a global expansionary monetary shock contributes to *reduce* the US external imbalance, rather than exacerbate it, which is prima facie a rather puzzling result. While a full analysis of this result goes well beyond the limited ambitions of the present paper, it is nevertheless interesting to note that also in this dimension the US appears to be different from the euro area and Japan, as far as the adjustment to an expansionary global monetary shock is concerned.[22]

Overall, our conclusion is that while the impact on euro area and (though to a lesser extent) Japanese variables seems quite in line with previous results in the literature, the reaction of the US economy is substantially different. As argued by Schmidt (2006), one explanation for this divergence could be related to an asymmetry in the price-setting mechanisms of non-US firms, which tend to price in US dollars (the dominant currency) in the US market (pricing to market), while US firms tend to price in US dollars both at home and abroad. However, it is not immediately obvious how this explanation could apply since we are not able to find the expected positive impact of the monetary expansion abroad on the US real effective exchange rate in the first place. The conclusion of the analysis seems to be that global liquidity shocks affect the US only through a cost-push shock related to external price developments.

4.3 Variance decomposition analysis

How important are global variables, global liquidity included, in explaining real and monetary developments in the world's three largest economies? An answer to this question can be provided by means of the variance decomposition analysis, reported in **Tables 4-6** up to 30 quarters, based on the same Choleski ordering as in the previous section. In particular, we report the contributions of the global (i.e. G4) variables on the variability of real GDP, the GDP deflator, broad money and the asset price index (the latter for the alternative specification of the baseline models discussed earlier) in the three economies. For the US, we also report the variance decomposition analysis for the current account of the balance of payments.

Overall, the variance decomposition analysis uncovers five interesting results. First, the impact of global shocks on domestic variables is smallest in the US, medium in Japan, and largest in the euro area, in line with the relative degrees of openness of these economies. Second, especially for the euro area but also for the US and Japan, the variability of the price level is very significantly influenced by global factors (which explain 73 per cent of the variability in the euro area). Third, shocks to global broad money appear to have a sizeable independent impact on the variability of domestic broad money, which is largest in the euro area (though considerably smaller than estimated in Sousa and Zaghini 2003) and smallest in the US. Fourth, there is also a (quite surprising) impact of global shocks on asset price variability, which ranges between 11 and 17 per cent across the three economies. Last, global output shocks appear to matter to an important degree in the euro area and Japan (quite in line with the recent results of Borio and Filando 2006) but much less so in the US.[23] Moreover, shocks to global output as identified in the model matter more or less in the same way as broad money shocks in explaining the variability of *domestic output*, suggesting that there is significant cyclical information in the behaviour of monetary aggregates at a global level.

4.4 Robustness checks

We conduct two robustness checks of the analysis described in the previous section. The first consists of computing the excess money variable based on *narrow* money, rather than broad money. The two measures are quite collinear at the global level. Unsurprisingly, when repeating the whole analysis based on narrow money, we come to very similar results from a

[22] We also tried to include different trend measures in the VAR, hoping to better capture a secular trend in the US current account position, but this did not change the results substantially.
[23] Note that, due to the presence of a linear trend in the VAR models, the output equation in each model could be construed as being a model of de-trended output and hence of the output gap, similar to Borio and Filardo (2006).

qualitative point of view, although with somewhat less statistical significance. Part of the apparently lower information content of global narrow money compared with global broad money might be related to the statistical problems experienced by the US M1 aggregate, related to the introduction of sweep programs in the mid-1990s.[24]

A second robustness check concerns the method of aggregation. In particular, we check whether the results are robust with respect to the aggregation of the global liquidity measure. In addition to using fixed real GDP weights at PPP exchange rates we also use directly PPP exchange rates to transform national monetary aggregates into a common currency. As liquidity in one country can, in fact, be converted into another country's currency and thus liquidity via the foreign exchange market, a case could also be made for using an aggregation based on actual market exchange rates. Although market exchange rates are considerably more volatile than PPP exchange rates, thereby affecting the overall aggregate, the results are again qualitatively in line with the PPP-based aggregation methods. Overall, the main results of the paper are found to be robust to the choice of aggregation method.

5. Conclusions

In this paper we have tried to provide a comprehensive analysis of the conceptual and empirical properties of a quantity-based measure of global excess liquidity. Moreover, we have surveyed the theoretical channels through which we could expect excess liquidity to spill over across borders, and provide some empirical evidence to bear on this question.

All in all, our analysis is able to reach two main conclusions. *First*, we find further support to the conjecture that monetary aggregates may convey some useful information on variables (such as a "spectrum of yields") which matter for aggregate demand and hence inflation. Thus we conclude that excess liquidity is a useful indicator of inflationary pressure at a global level and therefore merits some attention in the same way as the level of interest rates, if not possibly more.

Second, the channels though which excess liquidity might be transmitted across borders are both theoretically ambiguous and empirically rather elusive. By means of a Granger causality analysis we are able to find only scattered evidence of cross-border transmission. However, the VAR analysis (thanks to the sharper focus of the structural approach) is able to find evidence of a significant spill-over of global liquidity on the euro area economy and (albeit to a somewhat more limited extent) in Japan, which is in line with the existing empirical literature which mainly suggests that foreign monetary shocks have an expansionary effect. From this perspective, we find that the euro area economy appears to behave very much like a small open economy, although of course the situation may have changed with the introduction

[24] See Dutkowsky, Cynamon and Jones (2005).

of the euro and the establishment of a common monetary policy. It is also interesting to note that the impact of global excess liquidity on the US economy is found to be significantly more limited, has a different direction compared with the euro area and Japan and is generally much less straightforward to explain on the basis of the existing analytical frameworks (Mundell-Fleming or New Open Economy Macro). It appears that global liquidity plays a different and more limited role for the "leader" currency in the international monetary system. This is an issue which might be worth taking up in future research.

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<u>ANNEX 1</u> – An illustrative portfolio model of international liquidity spillovers

The basic set-up of the model is as follows:

$$M = m\left(\underset{-}{i}, \underset{-}{i^*}, \underset{-}{r}, \underset{+}{Y}\right) W$$
$$B = b\left(\underset{+}{i}, \underset{-}{i^*}, \underset{-}{r}, \underset{-}{Y}\right) W$$
$$eB^* = b^*\left(\underset{-}{i}, \underset{+}{i^*}, \underset{-}{r}, \underset{-}{Y}\right) W$$
$$K = k\left(\underset{-}{i}, \underset{-}{i^*}, \underset{+}{r}, \underset{-}{Y}\right) W$$

$$W = M + B + eB^* + K$$

The model consists of four asset markets: domestic money, M, domestic bonds, B, foreign bonds, B^*, and one additional asset, K, which might be thought of as physical capital (see, for example, Tobin (1969). The local-currency supply of all assets is fixed and demand is proportional to overall wealth. The portfolio share of each asset depend positively on the assets own rate of return and income and negatively on the return on other assets. The last equation represents the budget constraint that overall wealth equals to the sum of the various asset holdings. The main changes relative to the standard portfolio balance model is that money holdings are endogenised, thereby allowing for the possibility of endogenous changes in money holdings. In addition, changes in the holdings of the physical assets are associated with portfolio adjustment costs, due to, for example, the higher information-intensity of such assets.

Regarding the endogeneity of money, it is assumed that the central bank sets the domestic interest rate rather than the supply of money and that private agents can adjust there holdings of money by switching between money and domestic bonds via the central bank. Agents can obtain money by transforming domestic bonds one-for-one into currency holdings. This mechanism can be thought of in a number of ways. It can, for example, be viewed as open market operations with the initiative lying with private individuals. Alternatively, one can think of it as the central bank standing ready to provide money against eligible collateral, e.g. domestic bonds, at a policy-determined exogenous interest rate.

The introduction of adjustment costs introduces a distinction between short-run and long-run equilibrium. In the short run, agents are assumed to optimise their portfolios only over a restricted set of financial assets excluding physical capital. Only after some time, once sufficient information has been accumulated, do agents adjust their entire asset holdings of financial and real assets.[25]

Consider for the purpose of illustration, the case of an expansionary monetary policy in the foreign country, captured by a reduction in foreign interest rates. Although not explicitly modelled, this is likely to result in an increase in foreign money holdings, as foreign agents shift out of foreign bonds and into foreign money due to the reduced opportunity costs of monetary balances.[26] The reduction in foreign interest rates likewise increases the relative attractiveness of domestic money and bonds for domestic agents – and in the long-run also that of real assets. In the short-run, the change in domestic money holdings as a result of foreign monetary easing is ambiguous. Money holdings increase in the short run, if the elasticity of the demand for money with respect to the foreign interest rate is, in absolute terms, larger than the elasticity of the demand for domestic bonds. A similar ambiguity of the response of money holdings exists for the long-run equilibrium, with the corresponding necessary condition for an increase in addition depending on the elasticity of real asset demand. Under certain conditions, the short-run response of money exceeds that in the long run.[27] In particular, short-run money balances may be larger than what agents are willing to hold eventually once investment into information-intensive real assets is also considered. In that case, money balances will be reduced over time as investment demand for real assets increases. Equilibrium is reached once the return on real assets is sufficiently reduced to restore portfolio balance. In reality, this adjustment is likely to involve also an increase in the prices of the various real assets, which may also include durable consumer goods, and may thus result in an increase in inflation rates, and possibly also activity.

[25] This timing effect introduced by adjustment costs could, for example, be rationalised by a non-linear costs function. In particular, if adjustment costs rise disproportionately with the size of the adjustment, as in the case for a quadratic cost function, the desired adjustment is optimally spread smoothly over time, with the short-run and long-run equilibria being the starting and end points of this process. Alternatively, information could be thought of as following a diffusion process, which in the case of sunk adjustment costs, provides an incentives for a wait-and-see approach to portfolio adjustment.

[26] For the sake of clarity of argument, we abstract from the possibility that also in the case of foreign money holdings short-run and long-run equilibrium are likely to differ.

[27] Concretely, an overshooting of money holdings in the short-run occurs if the following condition holds:

$$0 < \underset{(+/-)}{\left(\frac{\varepsilon_{m,r} - \varepsilon_{b,r}}{r}\right)} \left[\underset{(+/-)}{\underset{(+/-)}{(m_i + b_i)}k - \underset{(-)}{(b+m)}k_i} \right].$$

ANNEX 2 – TABLES AND FIGURES

Figure 1: G5 variables, 1981-2004

(Aggregate of US, euro area, Japan, UK and Canada, using real GDP weights at PPP exchange rates of 1995; source: OECD, IMF, BIS.)

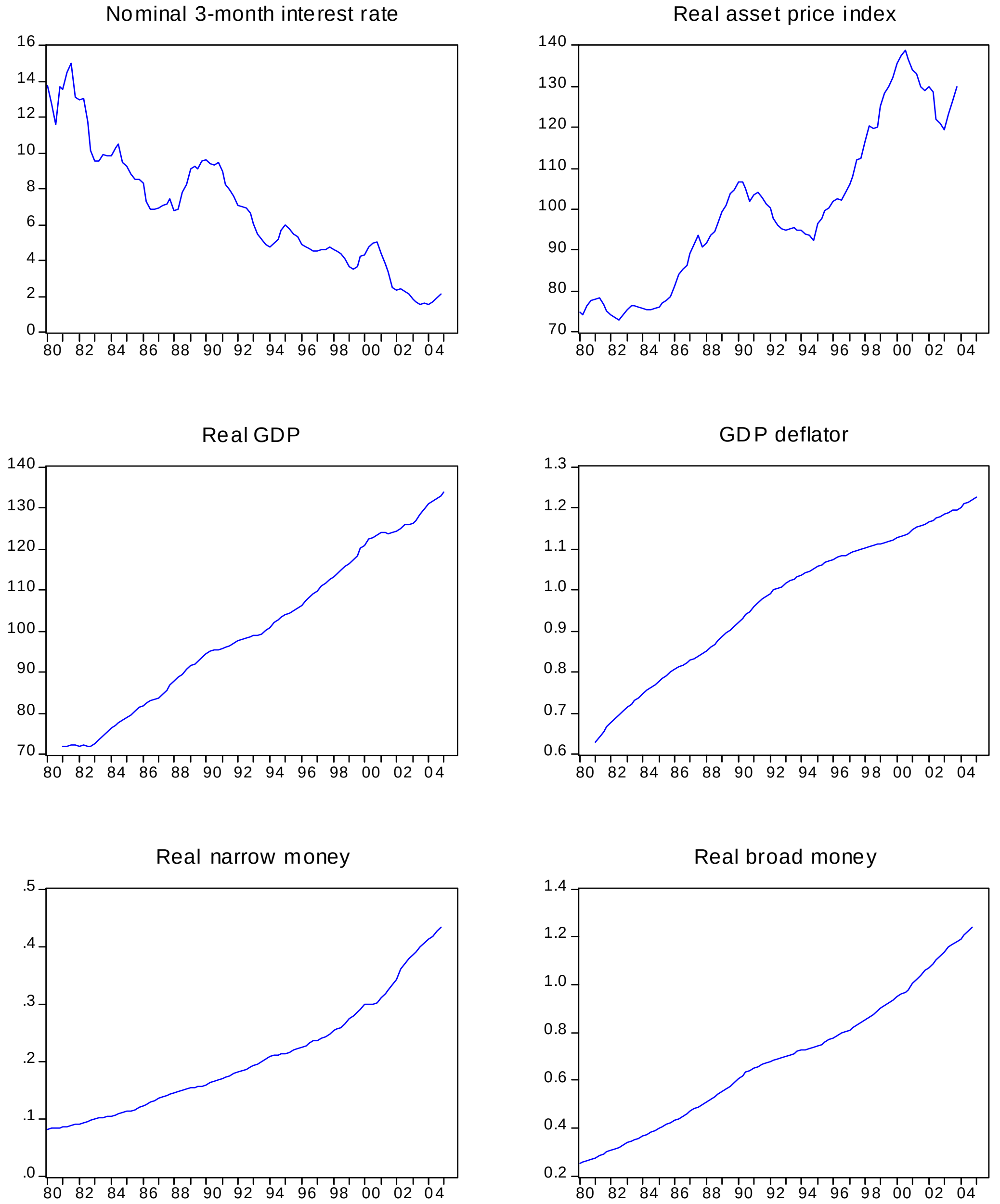


Table 1: Share of variance explained by the common factor – G7 plus euro area

	eura area	US	Japan	UK	Canada	Average
Differenced narrow money	0.16	0.02	0.19	0.31	0.10	0.16
Differenced broad money	0.05	0.51	0.11	0.05	0.21	0.19
Time trend narrow money	0.40	0.20	0.71	na	0.74	0.51
Time trend broad money	0.46	0.61	0.65	0.02	na	0.44
HP-filtered narrow money	0.09	0.95	0.05	0.01	0.26	0.27
HP-filtered broad money	0.19	0.48	0.00	0.13	0.94	0.35

Note: The different de-trending methods are applied to broad and narrow excess liquidity (money/nominal GDP). Sample period: 1980 Q1 to 2004 Q4.

Table 2: Granger causality test of excess liquidity common factor on individual country's excess liquidity and nominal GDP - Full sample results

H_0 = The common factor in the excess liquidity measure does not cause corresponding money aggregate/nominal GDP in country X full sample

	Money aggregates					
	Differenced		HP-filtered		Time trend	
	broad	narrow	broad	narrow	broad	narrow
euro area	0.82	3.48 **	0.70	0.48	0.99	3.98 ***
US	13.42 ***	0.66	1.34	123.50 ***	2.65 **	5.19 ***
Japan	1.09	4.34 ***	0.50	1.54	3.21 **	4.44 ***
UK	1.34	11.85 ***	0.73	0.50	0.41	4.52 ***
Canada	5.97 ***	3.72 ***	65.12 ***	3.88 ***	5.48 ***	3.42 **
China	2.35 *	0.74	0.37	0.77	1.91	0.76
India	0.82	1.78	2.85 *	2.01	0.85	0.98
Korea	0.97	3.43 **	0.97	2.96 **	1.98	1.08
Thailand	0.80	1.04	1.88	1.31	0.80	0.66
Taiwan	0.46	1.39	1.75	1.56	0.42	0.76
Brazil	0.60	0.14	0.37	1.23	2.11 *	4.83 ***
Mexico	0.73	0.43	0.78	1.65	0.80	0.06
Australia	0.71	1.80	1.71	1.60	0.55	1.89
New Zealand	0.75	1.20	2.55 **	2.30 *	0.16	1.76
South Africa	0.57	1.55	0.15	1.25	1.84	0.42
	Nominal GDP					
	Differenced		HP-filtered		Time trend	
	broad	narrow	broad	narrow	broad	narrow
euro area	0.51	4.81 ***	0.77	0.87	0.49	0.83
US	1.45	1.17	0.72	2.92 **	1.35	3.44 **
Japan	0.96	4.36 ***	0.63	1.78	2.55 **	1.82
UK	1.60	4.02 ***	0.52	1.39	1.49	0.17
Canada	2.22 *	1.99	0.83	2.56 **	4.16 ***	1.17
China	0.34	1.13	0.34	1.15	0.83	0.49
India	1.29	1.16	0.36	0.70	1.79	2.20
Korea	0.89	2.54 **	0.79	0.27	0.70	2.11 *
Thailand	0.14	0.89	0.70	2.47 *	0.28	0.18
Taiwan	0.14	3.61 ***	2.14 *	1.17	0.65	2.54 **
Brazil	0.12	0.56	1.27	1.94	0.33	0.32
Mexico	1.25	1.41	2.52 **	1.66	0.72	1.02
Australia	1.77	2.00	0.99	1.40	0.28	1.35
New Zealand	0.39	0.95	0.34	3.32 **	0.32	0.40
South Africa	0.72	2.62 **	0.02	1.08	1.24	1.61

Note: *** indicates significance at the 1% level, ** at 5% and * at 10%.
The sample period starts in 1980Q1 in the case of Australia, Canada, euro area, Japan, Korea, South Africa, United Kingdom and and United States, 1995Q4 for China, 1997Q2 for India, 1982Q2 for Mexico, 1988Q2 for New Zealand, 1994Q1 for Thailand, 1984Q1 for Taiwan and 1992Q1 for Brazil.

Table 3: Granger causality test of excess liquidity common factor on individual country's excess liquidity and nominal GDP - Recent sub-sample results

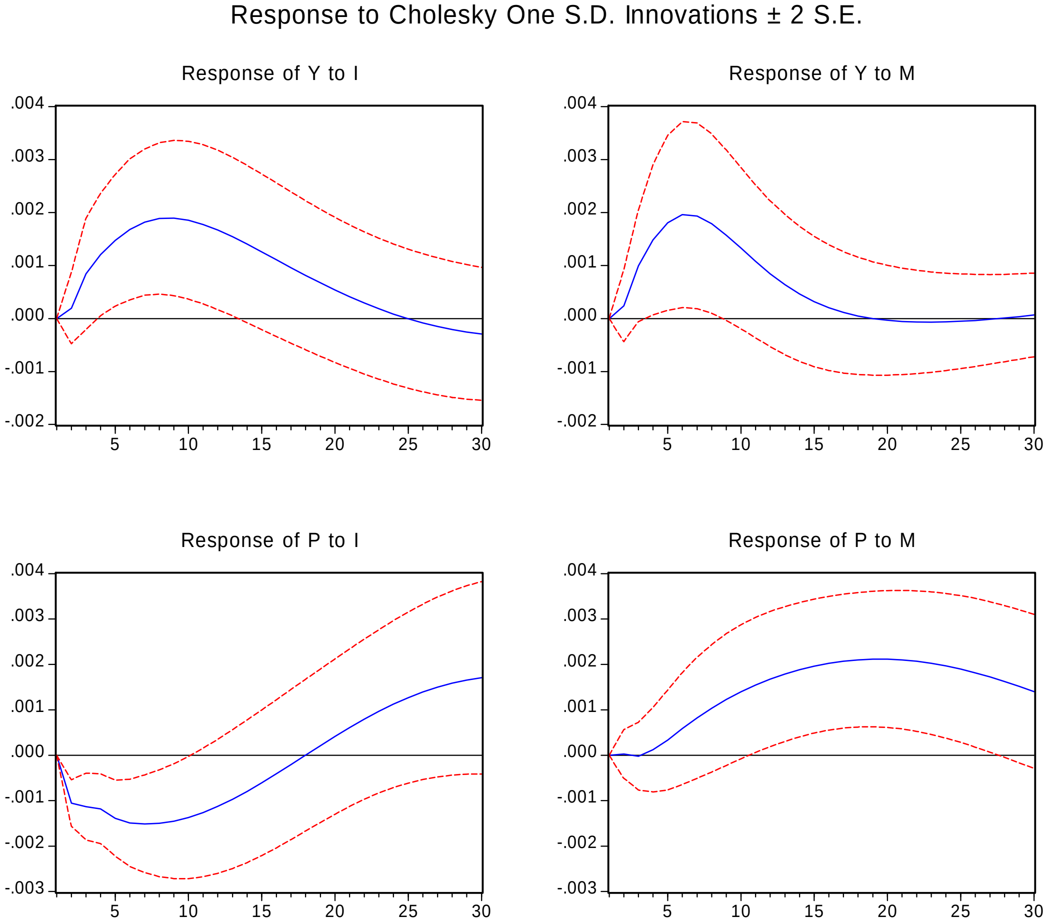
H_0 = The common factor in the excess liquidity measure does not cause corresponding money aggregate/nominal GDP in country X
full sample

	Money aggregates					
	Differenced		HP-filtered		Time trend	
	broad	narrow	broad	narrow	broad	narrow
euro area	1.85	1.61	0.59	0.15	2.13 *	5.21 ***
US	9.12 ***	0.60	2.38 *	38.23 ***	2.10 *	2.30 *
Japan	1.68	3.53 **	0.37	2.77 **	4.24 ***	4.20 ***
UK	0.51	5.96 ***	0.20	1.66	0.20	2.57 *
Canada	3.74 ***	1.15	43.53 ***	1.85	1.93	1.76
Korea	1.22	2.96 **	0.96	0.69	1.14	0.76
Taiwan	0.47	4.04 ***	1.22	1.94	0.49	1.41
Mexico	0.51	1.12	0.30	0.94	0.28	0.30
Australia	0.81	3.54 **	0.91	4.20 ***	0.25	2.60 **
New Zealand	0.79	2.42 *	1.88	3.18 **	0.60	1.84
South Africa	1.87	3.13 **	0.65	2.20 *	2.97 **	0.78
	Nominal GDP					
	Differenced		HP-filtered		Time trend	
	broad	narrow	broad	narrow	broad	narrow
euro area	0.45	0.92	0.85	0.24	0.94	0.59
US	1.47	0.50	1.29	0.82	2.23 *	1.82
Japan	2.98 **	1.99	1.13	1.88	4.22 ***	0.54
UK	1.88	1.94	0.32	0.55	0.57	0.08
Canada	1.72	1.78	1.01	2.00	3.58 **	0.97
Korea	0.93	1.66	0.90	0.31	0.36	2.71 **
Taiwan	0.49	2.78 **	3.20 **	0.99	1.00	1.95
Mexico	0.23	1.92	0.74	0.91	0.39	1.89
Australia	1.18	3.96 ***	1.75	1.06	0.21	3.52 **
New Zealand	1.38	1.52	0.21	3.71 **	1.25	0.67
South Africa	0.27	2.75 **	0.66	0.63	0.54	5.06 ***

Note: Some country are excluded in this analysis as the full sample is too short to permit a meaningful sub-sample analysis. *** indicates significance at the 1% level, ** at 5% and * at 10%. The short sample period starts in 1990Q1.

<u>Figure 2</u> – Impulse responses to expansionary monetary shocks: G5 model

(Responses of the log of real GDP, Y, and the log of the GDP deflator, P, to a shock to the log of broad money, M, and to the nominal interest rate, I, the latter with a minus sign)



<u>Figure 3</u> – Impulse responses to expansionary monetary shocks: G5 model, including the real asset price

(Responses of the log of real GDP, Y, and the log of the GDP deflator, P, and the real asset price Q to a shock to the log of broad money, M, and to the nominal interest rate, I, the latter with a minus sign)

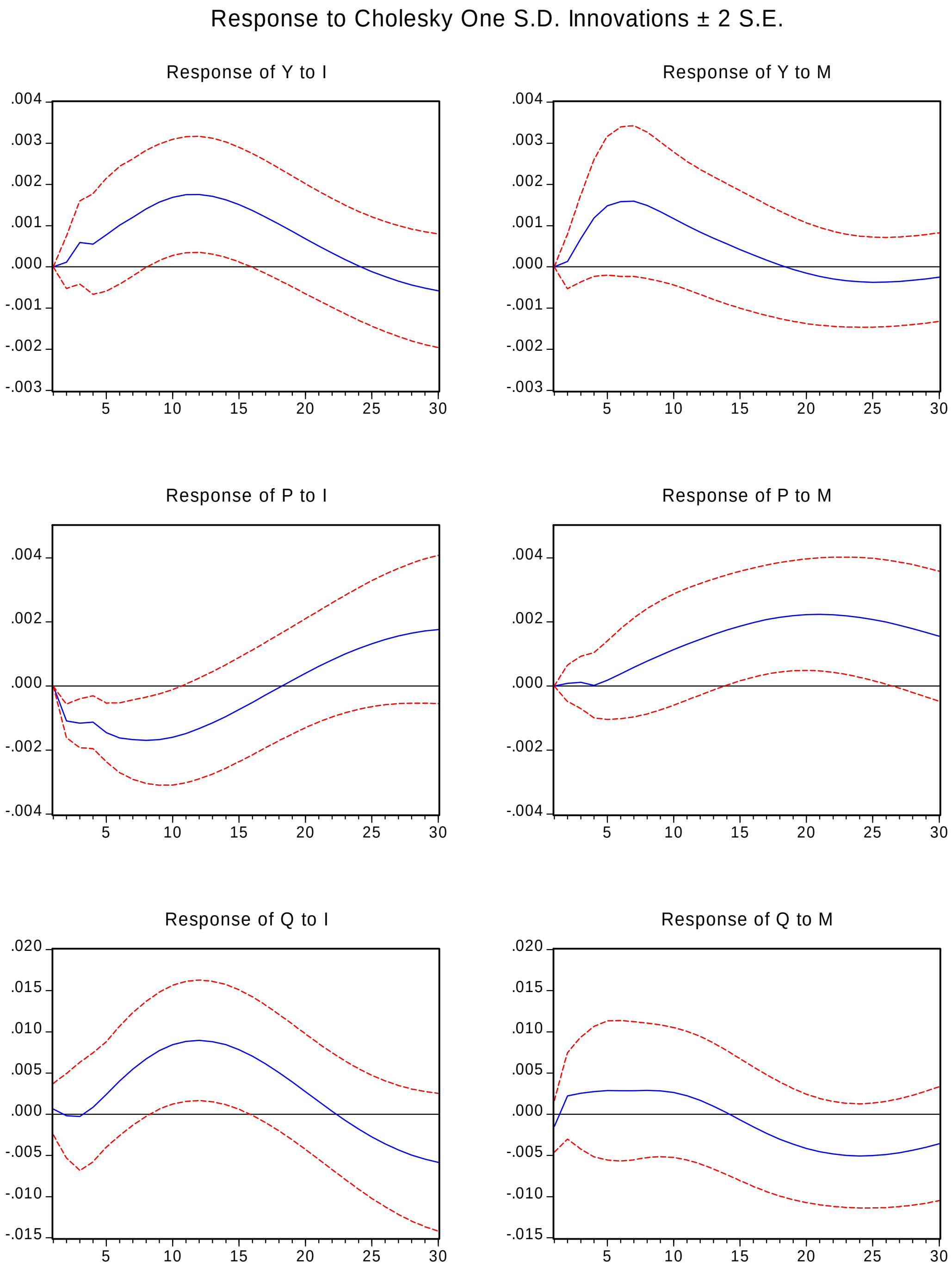
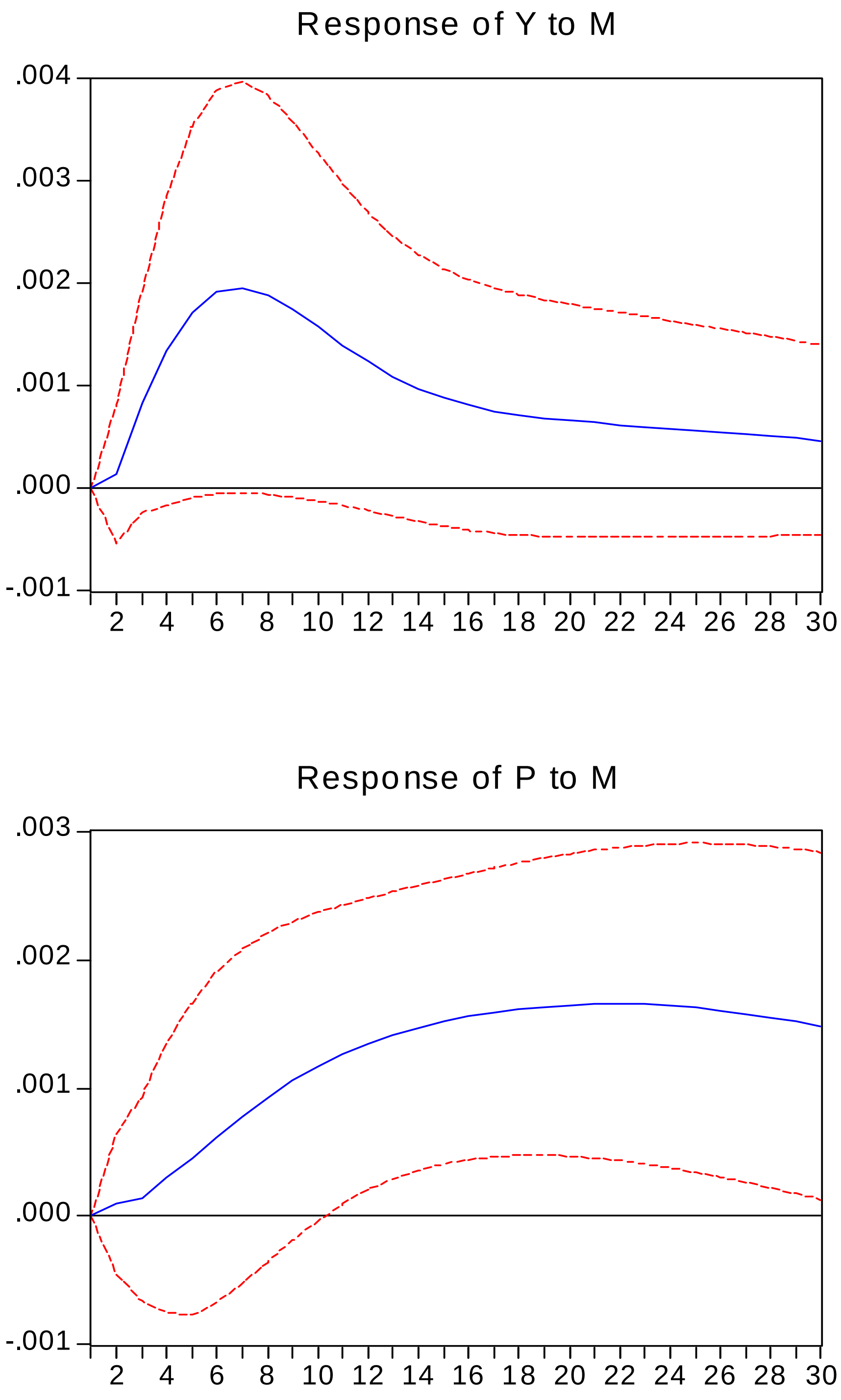


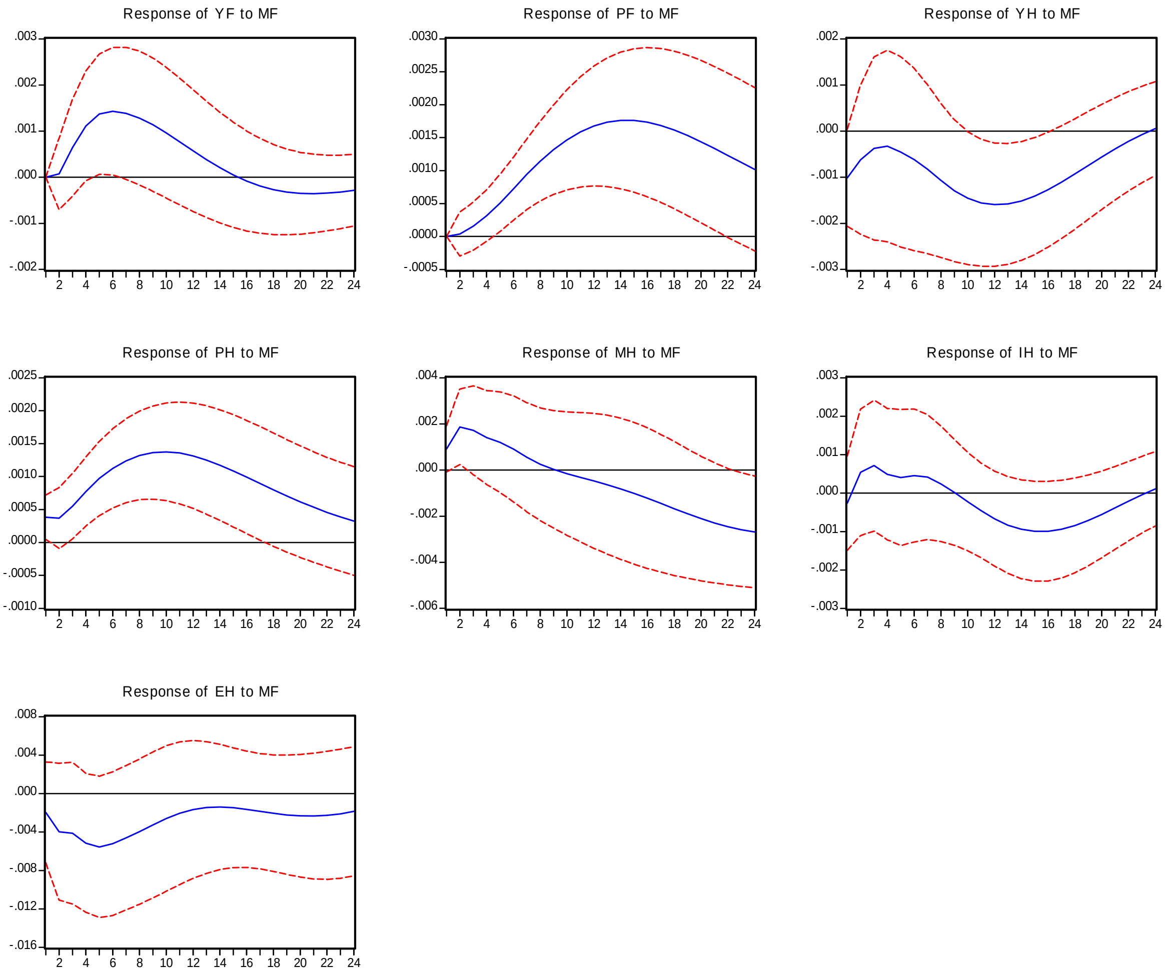
Figure 4 – Impulse responses to excess money, trivariate VAR model (excluding the nominal interest rate)

(Responses of the log of real GDP, Y, and the log of the GDP deflator, P, to a shock to the log of broad money, M)



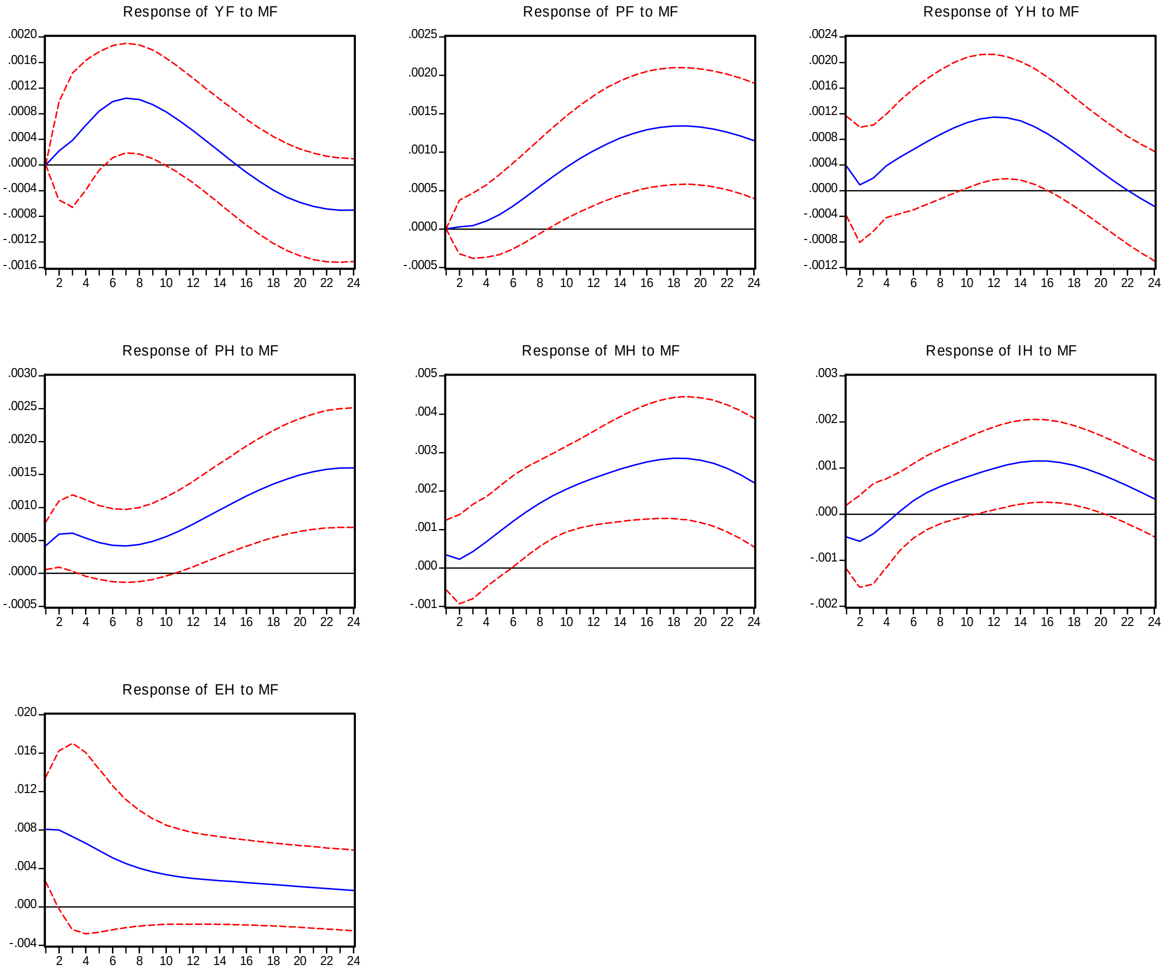
<u>Figure 5</u> – Impact of a shock to G4 excess liquidity (G5 excluding the US) on US domestic variables

(Responses of the log of G4 real GDP, YF, the log of the G4 GDP deflator, PF, the log of domestic real GDP, YH, the log of the domestic GDP deflator, PH, the log of domestic broad money, MH, the domestic nominal 3-month interest rate, IH, and the log of the domestic real effective exchange rate, EH, to a shock to the log of G4 excess liquidity, MF)



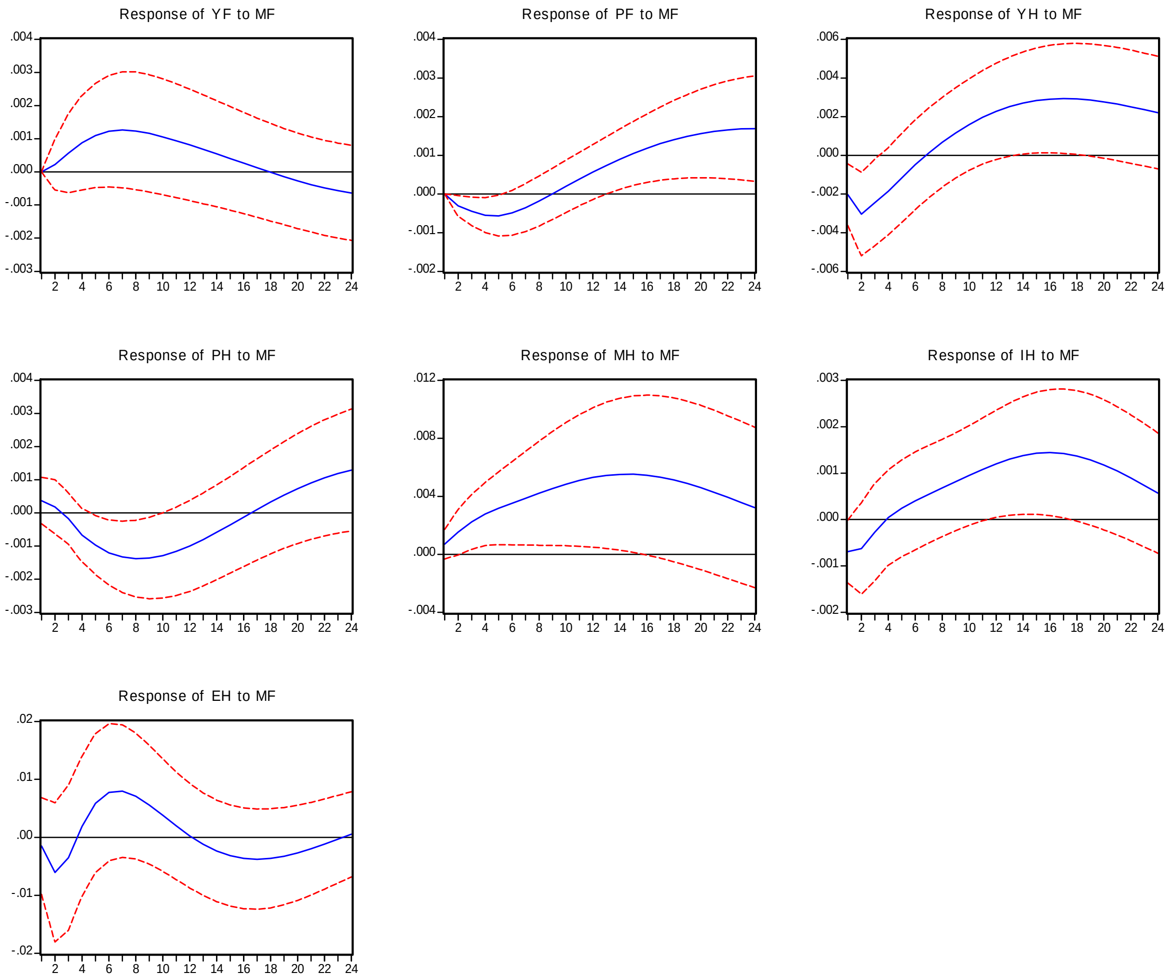
<u>Figure 6</u> – Impact of a shock to G4 excess liquidity (G5 excluding the euro area) on euro area domestic variables

(Responses of the log of G4 real GDP, YF, the log of the G4 GDP deflator, PF, the log of domestic real GDP, YH, the log of the domestic GDP deflator, PH, the log of domestic broad money, MH, the domestic nominal 3-month interest rate, IH, and the log of the domestic real effective exchange rate, EH, to a shock to the log of G4 excess liquidity, MF)



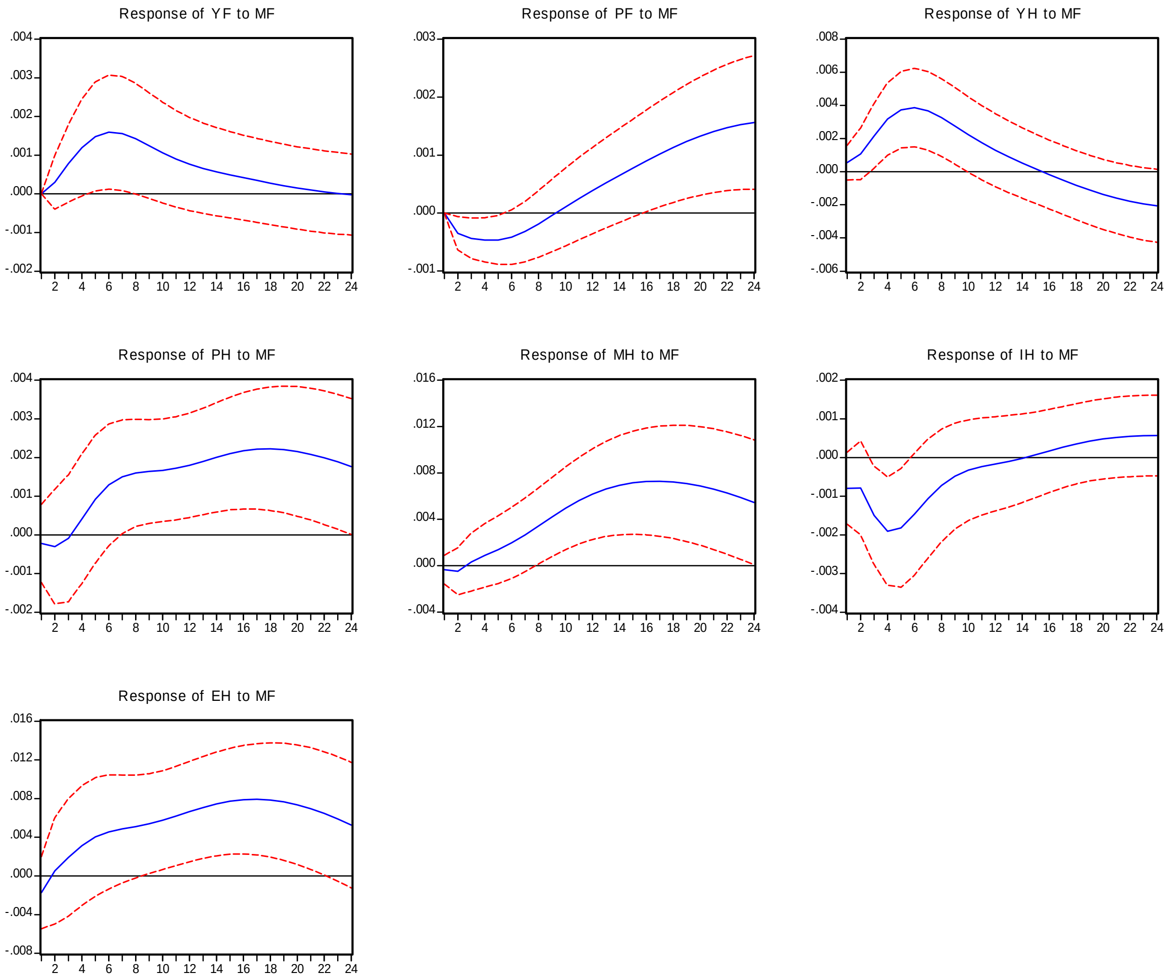
<u>Figure 7</u> – Impact of a shock to G4 excess liquidity (G5 excluding Japan) on Japanese domestic variables

(Responses of the log of G4 real GDP, YF, the log of the G4 GDP deflator, PF, the log of domestic real GDP, YH, the log of the domestic GDP deflator, PH, the log of domestic broad money, MH, the domestic nominal 3-month interest rate, IH, and the log of the domestic real effective exchange rate, EH, to a shock to the log of G4 excess liquidity, MF)



<u>Figure 8</u> – Impact of a shock to G4 excess liquidity (G5 excluding Canada) on Canadian domestic variables

(Responses of the log of G4 real GDP, YF, the log of the G4 GDP deflator, PF, the log of domestic real GDP, YH, the log of the domestic GDP deflator, PH, the log of domestic broad money, MH, the domestic nominal 3-month interest rate, IH, and the log of the domestic real effective exchange rate, EH, to a shock to the log of G4 excess liquidity, MF)



<u>Figure 9</u> – Response of the real asset price index to a unit standard deviation shock in global broad money

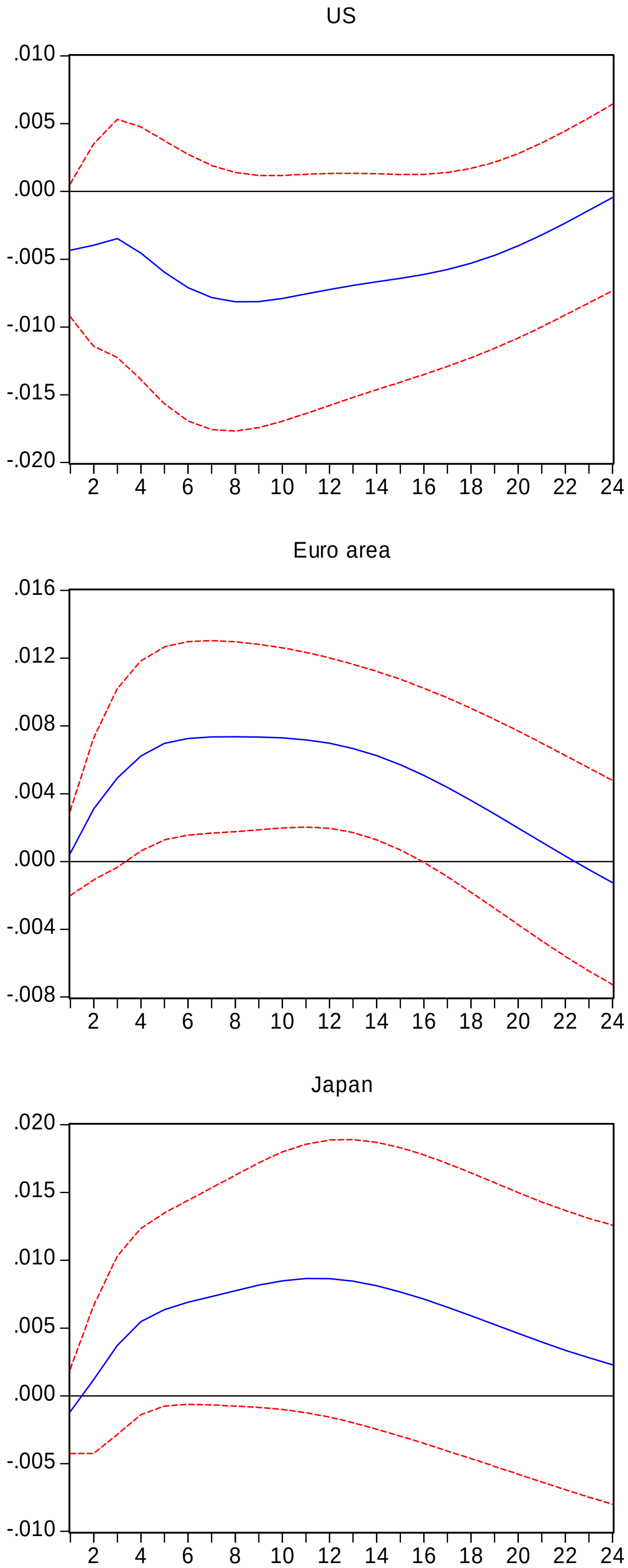


Table 4 – **Variance decomposition for the US**

	Output	**Price level**	**Broad money**	**Asset price**	**Current account**
Global output	10.3	3.2	6.4	0.8	7
Global price level	1.6	4.1	6	0.3	4.3
Global broad money	10	27.7	11.1	12.9	17.3
Total global	**21.9**	**35**	**23.5**	**14**	**28.6**
Domestic broad money	6.8	20	36.5	13	6.1
Domestic interest rate	1.5	3.2	6.3	8.2	7.9
Other domestic	69.8	41.8	33.7	64.8	57.4
Total domestic	**78.1**	**65**	**76.5**	**86**	**71.4**

Note: Variance decomposition at 30 quarters based on the eight-variable VAR (see text for further explanations). The decomposition for the asset price and for the current account of the balance of payments refers to the variants of the baseline VAR model in which these variables replace the real effective exchange rate (as explained in the main text).

Table 5 – **Variance decomposition for the euro area**

	Output	**Price level**	**Broad money**	**Asset price**
Global output	13.9	12.4	8	5.8
Global price level	21.5	29.7	15.9	20.9
Global broad money	8.5	30.7	27.5	15.7
Total global	**43.9**	**72.8**	**51.4**	**42.4**
Domestic broad money	3	4.4	24.9	10.8
Domestic interest rate	4.1	2.9	7.5	1.5
Other domestic	49	19.9	16.2	45.3
Total domestic	**56.1**	**27.2**	**48.6**	**57.6**

Note: Variance decomposition at 30 quarters based on the eight-variable VAR (see text for further explanations). The decomposition for the asset refers to the variants of the baseline VAR model in which these variables replace the real effective exchange rate (as explained in the main text).

Table 6 – **Variance decomposition for Japan**

	Output	**Price level**	**Broad money**	**Asset price**
Global output	15.4	22.8	28.1	20.3
Global price level	1.6	3.4	1.2	0.9
Global broad money	18.1	10.9	19.8	11.4
Total global factors	**35.1**	**37.1**	**49.1**	**32.6**
Domestic broad money	14.8	24	20.8	12.6
Domestic interest rate	14	12.8	15.5	32.1
Other domestic	36.1	26.1	14.6	22.7
Total domestic factors	**64.9**	**62.9**	**50.9**	**67.4**

Note: Variance decomposition at 30 quarters based on the eight-variable VAR (see text for further explanations). The decomposition for the asset price refers to the variants of the baseline VAR model in which these variables replace the real effective exchange rate (as explained in the main text).

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