


FACULTEIT ECONOMIE EN BEDRIJFSKUNDE

# UNIVERSITY OF GHENT

# FACULTY OF ECONOMICS AND BUSINESS ADMINISTRATION

**ACADEMIC YEAR 2010 – 2011**

# The Impact of Global Liquidity on Commodity and Asset Prices

Master's dissertation submitted to obtain the degree of
Master in Economics

**Duncan Van Limbergen**

**under the leadership of prof. dr. G. Peersman**

**and the guidance of I. Van Robays**


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Duncan Van Limbergen

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# Nederlandstalig uitreksel

Deze paper evalueert de relatie tussen de 'globale geldhoeveelheid' en huizenprijzen, aandelenprijzen en grondstoffenprijzen. Gedurende de recente economische crisis is de publieke interesse in dit onderwerp sterk toegenomen, doch is de literatuur hieromtrent relatief schaars. Het doel van deze paper is de bestaande literatuur aan te vullen, gebruik makende van twee innovaties. Ten eerste introduceren we data omtrent opkomende groeimarkten ("emerging market" countries), wat onze data set toelaat 85 procent van het globale BBP te omvatten voor de periode 1990-2007. Ten tweede beogen we een 'eclectische' benadering van het onderwerp, waarbij we zowel huizen-, aandelen- als grondstoffenprijzen trachten te verklaren aan de hand van 'globale' monetaire beleidschokken. Deze methode laat ons toe om een diepgaande, theoretisch gebaseerde vergelijking te maken tussen de reacties van deze verschillende activa.

Op econometrisch vlak hanteren we de structurele VAR methode en schatten we twee basismodellen, namelijk één voor vastgoed- en aandelenprijzen en één voor grondstoffenprijzen, gebruik makende van data voor de periode van 1990Q1 tot 2007Q4. Onze resulaten suggereren dat er een sterke asymmetrie bestaat tussen de reactie van de verschillende prijzen op evoluties in 'globaal monetair beleid'. Huizenprijzen blijken erg sterk, doch vertraagd te reageren op zowel globale liquiditeitsschokken als 'globale interestvoetschokken'. Deze effecten zijn in mindere mate ook aanwezig voor grondstoffenprijzen. Inzake aandelenprijzen wordt er geen dergelijk patroon gevonden, wat impliceert dat andere drijfveren de evolutie van globale aandelenprijzen bepalen. Verder observeren we dat ontwikkelingen inzake globale economische activiteit zowel aandelenprijzen als grondstoffenprijzen sterk beïnvloeden, hoewel ze maar een gelimiteerde impact op huizenprijzen uitoefenen.

Aanvullend voeren we een 'cross-country' analyse uit, ten einde na te gaan of de aggregatie van nationale huizen- en aandelenprijzen mogelijk de

uitkomsten vertekent. De resultaten inzake huizenprijzen wijzen uit dat de Verenigde Staten – en in beperkte mate de Eurozone – krachtig reageren op globale liquiditeitsschokken, terwijl de Japanse huizenmarkt onaangetast blijft. Deze asymmetrische bevindingen suggereren een sterk belang van binnenlandse determinanten. Betreffende de impact van globale liquiditeit op aandelenprijzen duiden de resultaten op een duidelijkere reactie in opkomende groeimarkten ten opzichte van ontwikkelde landen. Dergelijke observaties lijken op het bestaan van 'push' en 'pull' kanalen te duiden.

De door ons aangebrachte innovaties leiden tot bijkomende conclusies. Betreffende de inclusie van opkomende groeimarkten, vinden we gelijkaardige resulaten als in bestaande literatuur, doch verschilt de magnitude van sommige prijsreacties bijwijlen. Inzake het eclectische karakter van deze paper, rapporteren we het bestaan van een sterke asymmetrie tussen de reacties van huizen-, aandelen- en grondstoffenprijzen. Als mogelijke verklaring wijzen we op verschillen in elasticiteiten en de idiosyncratische elementen van bepaalde activa.

# The Impact of Global Liquidity on Commodity and Asset Prices

Duncan Van Limbergen

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**Abstract**

This paper investigates the relationship between global liquidity and housing, equity and commodity prices by means of an SVAR approach. We construct a global liquidity measure including data on both developed and emerging market countries, resulting in the coverage of 85 per cent of world GDP. Our findings suggest that 'global' monetary policy shocks have a significant impact on housing prices and, to a much lesser extent, commodity prices. Additional cross-country analysis reveals the existence of vast asymmetries in asset prices reactions between individual regions.

# Contents

# 1 Introduction

In this paper, we attempt to capture the relationship between 'global liquidity' and commodity and asset prices. The main incentive for research in the field of global liquidity is the surprising duality between public and academic attention concerning the topic. Both policy makers and professional commentators have pointed to global liquidity in explaining major macro-economic events, a prime example of this being the monetary conditions prior to the recent financial crisis. Surprisingly, thorough and applied academic research on the subject remains relatively scarce. Only a handful of papers focus specifically on the global dimension of liquidity, making it rather hard to formulate stylized facts regarding the topic. The goal of this work is to present additional evidence, while making use of a broad scope of data comprising various countries and asset classes. The impact of global liquidity on asset prices will be approached via a twofold analysis, namely a literary and an empirical one. First, the literature analysis provides a sound theoretical foundation for the link between global liquidity and asset prices. Second, the empirical section analyzes this relationship by means of both correlation and vector autoregression methods. The emphasis is put on a structural VAR analysis, which will attempt to capture asset price dynamics after a global liquidity innovation.

The main concern we have with existing relevant literature, is the neglect of a global dimension. Consequently, it could be argued that, on a country level, important international spill-over effects are mostly ignored. In addition, the price formation of asset prices – such as commodity prices – is not entirely defined. The inclusion of a global monetary aggregate in order to explain asset prices therefore seems justified and necessary. As one will notice in the literature section of this paper (section 2), the global liquidity topic is open to plentiful additional research. We attempt to fill this void, making use of two attributes that have – to our knowledge – not yet been fully discussed. The first attribute pertains to so-called emerging market

countries. Many papers on global liquidity cite the inclusion of monetary aggregates of these countries as a vital avenue in further research. Our aim is to take this suggestion seriously – to every extent possible, where data is available. The second attribute is the eclectic nature of this paper. The majority of the existing literature performs an analysis of global liquidity with respect to a limited amount of assets (e.g. solely commodities or housing), thereby reducing the research scope. We attempt to estimate the effect of a global liquidity shock to different assets, namely equity, housing and commodities. Because of this, we believe a thorough comparison between different asset reactions to a symmetric liquidity shock is possible. Different reactions between asset classes may stem from elasticity issues and time lags in transmission channels and responsiveness to monetary policy.

The concept of global liquidity has only recently started to receive greater attention. Prior to the outbreak of the financial crisis in 2007, as well as during the aftermath, a great deal of pundits referred to the relationship between (in most cases, excess) liquidity and financial stability implications. Most notably, this was done by some monetary policymakers themselves. Papademos (2007) focuses intensively on the mentioned liquidity link, connecting it to potentially harmful asset price boom-and-bust cycles. He links the growing size of foreign capital – and, hence, the stock of broad money – to potential policy implications in response to asset price developments. In this light, he argues that *"rather, these transactions have to be analysed with respect to their information content concerning their potential wealth effects on residents' income and on asset prices. Depending on the outcome of this analysis, the policy implications could be far from negligible. (. . . ) A potential interaction between globalization and monetary policy may inadvertently contribute to the creation of global excess liquidity which could later play a role in the development of asset price boom-and-bust cycles."* (Papademos,

2007).[1] The call for applied monetary analysis in order to achieve a better understanding of these global liquidity developments and their relationship with asset prices, underlines the relevance of this paper. Indeed, a pure focus on domestic monetary conditions could lead to a suboptimal insight – and policy response – with respect to asset price developments.

Public interest in the issue did not solely exist within central banks, as many renowned magazines and pundits picked up the concept as well. Remarkably, a certain amount of these publications already detected a significant trend prior to the beginning of the recent crisis. In February of 2005, The Economist remarks *"America's easy-money policy of recent years has spilled abroad. Low American interest rates have encouraged large inflows of capital into emerging economies, especially in Asia, as investors have sought higher returns. Central banks are supposedly the guardians of money. Yet between them they may have created the biggest liquidity bubble in history."*[2] This is far from the only attention this subject has received. The Economist, as well as Financial Times, regularly commented on loose policy stances. Often, the emphasis was put on the low real interest rates in the U.S., linking it with strongly accommodative monetary conditions around the globe.

Moreover, these lax conditions were regularly linked with developments in asset prices. As The Economist states in an another publication, *"the European Central Bank has been forced to hold the euro area's real interest rates negative for longer than might otherwise have been prudent. Mortgage lending in the single-currency zone is rising at an annual rate of 10%. In many countries, notably France and Spain, house prices are booming. (...) The flood of global liquidity has not, as in the past, pushed up inflation in the prices of goods and services. Instead it has inflated a series of asset-price bubbles and encouraged investors to take ever greater risks. (...) Holding*

[1] The effects of globalisation on inflation, liquidity and monetary policy, Speech by Lucas Papademos (ECB), p. 4.

[2] The Economist, Print Edition, February 24th, 2005.

*interest rates too low for too long creates excess liquidity, which is now more likely to spill into the prices of homes, shares or other assets than those of goods and services."*[3]

As a consequence, many authors argue monetary analysis could take on a significant role in predicting costly asset price bubbles (Alessi and Detken, 2009; Adalid and Detken, 2004; Detken and Smets, 2004). In this light, the interest for broader monetary aggregates as predicting forces urged us to perform a thorough analysis on the subject. Preceding work on the relationship between liquidity and asset prices underlines the possible existence of a strong connection. We hereby refer to Congdon (2005), who analyzes the link between broad money and asset price booms. By studying the portfolio allocation of financial institutions (e.g. pension funds), interesting implications emerge. Most importantly, there are indications that the 'money/asset ratio' (share of money in portfolios) tends to be stable in the long-run. This finding is linked to the notion of "too much money chasing too few assets" (Meltzer, 1995), hereby exerting asset price booms to emerge.

The remainder of this paper is organized as follows. Section 2 will provide a brief overview of the theory behind global liquidity and its link to asset prices. These theoretical foundations will be linked with the existing literature and highlight the key findings. Section 3 elaborates on the estimation methodology and data set, including details on how monetary aggregates were obtained. Section 4 presents a detailed discussion of the results and key findings of this paper. Section 5 concludes with a summary of our contributions to the literature and discusses possible avenues for further research.

[3]The Economist, Print Edition, February 3rd, 2005.

# 2 Theoretical Foundations and Literature Overview

In this section, we address the theoretical grounds on which the concept of global liquidity is based and through which channels it potentially affects economic conditions in general and asset prices in particular. Contrary to the aforementioned strong interest of policy makers and public commentators in the global liquidity issue, the literature concerning the topic is far from abundant. This implies it is not straightforward to present well-documented stylized facts. This section is organized as follows. First, the notion of global liquidity will be defined in detail. Next, we elaborate on the transmission channels through which global liquidity affects equity, housing and commodity prices. Accordingly, relevant existing empirical evidence will be discussed. For the sake of completeness, the impact of global liquidity on key macro-economic variables – namely, output and inflation – will receive further attention.

## 2.1 The 'Global Liquidity' concept

Broadly speaking, liquidity itself is a dubious term which can be interpreted in several ways. Fundamentally, the concept is widely used to depict the presence of money stock in international financial markets such as the interbank, money and equity markets.[4] Additionally, it can also refer to the total money supply as controlled by the central bank. In this light, liquidity is sometimes connected with the stance of the monetary authority and different interest rates. There is certainly a connection (namely, a positive shock to the money supply ought to lower interest rates), although one should not be tempted to causally link the supply of liquidity, central banks stances and interest rates. For example, it is argued that real long-term interest rates can be at a low (and thus, accommodative) level, despite central banks entering a tightening modus. This could be due to (global) savings and investment decisions interfering with money stocks and interest rates. Some authors

[4]IMF, World Economic Outlook 2007, page 34.

claim this was the case in the mid-2000s (Bernanke, 2005; Smaghi, 2007).

Therefore, care should be taken when interpreting an increase in liquidity as a deliberate policy move. The concept of liquidity should be regarded as linked with the notion of money demand. If, for example, future output expectations become more optimistic, money demand may increase as well. This could be due to an increased preference for shares, since future profits are expected to rise. In order to keep the interest rate unaltered, the monetary authority would have to increase the money supply. Another erroneous reasoning would be to put too much emphasis on the alleged link between market liquidity and central bank-provided liquidity. A clear example is the 2008 liquidity dry-up of interbank markets. While spreads increased strongly following the fall of Lehman Brothers, central banks worldwide took on a strong accommodative mode, providing liquidity using very lax standards.[5]

It is important to keep this variety of interpretations in mind when interpreting facts concerning liquidity. Indeed, as IMF notes in its World Economic Outlook (2007); *"Declines in risk premiums across various asset classes; buoyant prices in equity, bond, and real estate markets; low long-term real interest rates; and rising cross-border flows of capital have been interpreted as signs of "excess liquidity" in the global economy. At the same time, however, major central banks around the world have been in a tightening mode for some time. And in mid-August, liquidity dried up suddenly in several money markets and spreads on a number of risky asset classes widened markedly, prompting a significant injection of funds by central banks to stabilize short-term interest rates. What definition of liquidity can reconcile these facts?"*[6]

In this paper, global liquidity refers to the 'global monetary aggregate',

[5] Angelini, Nobili, and Picillo (2009); "The interbank market after August 2007: what has changed and why?"

[6] IMF, World Economic Outlook 2007, page 34.

as controlled by the central bank. Yet, this measure isn't rigorously defined. Intuitively, one could think of the total money supply 'around the globe'. Due to data limitations, it should be noted that it is virtually impossible to capture this global notion. However, it is argued that including most of the 'core' developed countries already presents a fairly good indication.[7] All discussed papers attempt to capture the global liquidity idea, however using different interpretations of liquidity. These different definitions are caused by the choice of the most appropriate money aggregate, the choice of included countries and the weights attached to different regions in the aggregation method. Each of these topics will be discussed, and different approaches in literature will be mentioned and compared.

1. **Appropriate money aggregate:** Since results may vary over different monetary aggregates, it is important to distinguish the various measures that can be used. Darius and Radde (2010) mention the U.S. base money stock plus the international reserves as global liquidity measure. They defend this approach by claiming that, since the U.S. dollar is seen as the 'world currency', this measure captures the 'global medium of exchange'. Adding international reserves to the U.S. base money is therefore seen as measuring the amount of exchange services. The Economist (2005, 2007) uses the same approach.

   In contrast to this '*exchange-based*' approach, Baks and Kramer (1999) opt for the usage of a global index, in which monetary aggregates are summed ('*monetary-based*' approach). Many papers follow the same modus operandi, e.g. Souza and Zaghini (2004) also refer to monetary aggregates in the major economies. This method is partly adopted by Rüffer and Stracca (2006), although they make use of the growth rate of broad money with respect to GDP developments. These kinds of measures lie broadly in the range of the 'excess liquidity' concept. This

[7]Between 1982 and 2009, the G-7 nations share of world GDP remained between 50 and 70 per cent. (IMF, World Economic Outlook databank, October 2010).

paper doesn't follow these customs and aims at complying with the basic money aggregate tradition.

2. **Included regions:** Almost all papers adopt the inclusion of the G-7 countries (Canada, France, Germany, Italy, Japan, USA, and U.K.). In some cases, the Euro area is included (Sousa and Zaghini, 2005; Belke et al., 2009). This approach may seem rather limited at first. The reason for this is twofold. Firstly, data for these countries is the least difficult to find. Secondly, these highly developed countries are at the heart of the world economy and are therefore impossible to ignore in constituting a 'global' liquidity measure. The Achilles heel of the majority of relevant literature is the absence of data comprising emerging market countries. This flaw is also consistently mentioned as possible avenue for further research in the global liquidity topic. This paper attempts to fill that void.

3. **Aggregation method:** In order to create a global indicator, it is vital to construct an aggregation method that weights every country's variables proportional to its share in the global aggregate. However, different methods are used in literature. The differences mainly focus on using constant or variable weights; converting national currency into 'global' currency using fixed or current rates and whether to adjust by price levels or not. Darius and Radde (2010), Giese and Tuxen (2007) and Belke et al. (2008) make user of a three-step approach. They convert individual series to a common currency (SDR). Then, individual country-weights are calculated using the share of domestic nominal GDP in global GDP. Eventually, they form an aggregate growth rate by multiplying the given country weights with the individual growth

rate of the considered measure.[8] Belke, Bordon and Hendricks (2009), Rüffer and Stracca (2006) and Sousa and Zaghini (2005) build on this method, although they make use of Purchasing Power Parity (PPP) exchange rates in order to calculate country weights. This way, they avoid depreciation bias, which would occur if a sharp downfall of the aggregate currency is not corrected for. The authors use the example of certain U.S. dollar depreciation periods which could have overestimated the global money growth when ignored.

The complexity regarding the global liquidity topic is however not limited to the choice of aggregation standards. Additional difficulties emerge because of the existence of international liquidity spillovers. Therefore, we discuss the implications for the conduct of monetary policy in an *international liquidity environment*. Some authors have argued that, since global liquidity increases are largely accompanied by surges in domestic asset prices, the role of domestic monetary policy is up for revision. An often-cited example of these international spillovers is the Bank of Japan (BoJ) case in recent years. By means of expanding base money, the Japanese central bank attempted to stimulate the domestic economy (which faced sluggish growth, often accompanied by deflation). The main ingredients of this policy course were close-to-zero interest rates and the accumulation of foreign reserves. As a consequence, investors started borrowing in Japanese Yen and used the latter to commence investing overseas ('carry trading'). These transactions affect monetary conditions abroad (downward pressure on interest rates and money supply increases), although the liquidity expansion was initially a Japanese matter (Hoffmann and Schnabl, 2007).

If central banks would find themselves indeed to be in a world with large liquidity spillovers, the call for enhanced international coordination would be justified. Since global liquidity factors are largely exogenous, the influence

[8]This kind of aggregation procedure was first introduced by Beyer, Doornik and Hendry (2000), who reconstructed historical Euro zone data.

of domestic monetary policy with regard to reaching inflation and output objectives could be strongly limited. Sousa and Zaghini (2004) disentangle Euro area liquidity and global (minus Euro area) liquidity and find that a positive shock to the global money supply gives rise to an increase in Euro area M3 figures. Baks and Kramer (1999) and Rüffer and Stracca (2006) raise additional evidence on these 'excess liquidity spillovers', although these spillovers are sometimes limited and the effects are not uniform over all countries. These findings suggest the presence of spillover effects and herding behavior of central banks.

## 2.2 Transmission channels

### 2.2.1 The impact on equity prices

The relation between money growth and equity prices is well-documented in literature (e.g. Mishkin, 2007). In this section, we give a brief overview of the so-called 'equity price transmission channel'. We focus on the two most-discussed variants, namely Tobin's Q and wealth effects. These suggest money growth may induce higher stock returns.

- **Tobin's Q:** In investment theory, the Q variable stands for the ratio of market value of capital to the replacement cost of capital. It is argued that investments will be higher if the Q value is higher, since the value of present capital is high or the cost of investment is low. Accommodative monetary policy (hence, money supply increase) can improve the Q value because of higher stock prices. Since lower interest rates will move economic agents away from saving and towards investment, equity prices may experience increases. As Q goes up, more incentives to invest emerge.

- **Wealth effects:** As argued above, monetary expansion has the potency to move up Tobin's Q and stock prices. Since economic agents holding stocks experience a growth in wealth, they could be inclined to

raise consumption and investment expenditures. These wealth effects may in turn increase equity prices again.

Of course, equity prices can move purely because of business cycle developments or fundamental drivers. Suppose economic prospects brighten, money demand increases and, hence, so does liquidity. These developments mostly coincide with higher stock returns, since there is a liquidity effect and an expectations effect (corporate profits are expected to rise). It is therefore useful to check whether global liquidity was behind noticeable equity price movements, and whether monetary policy indeed had the capability to limit (excessive) movements. The literature is abundant on this topic, so we will limit our literature review and own research to the initial relationship between global liquidity and equity prices.

Furthermore, Baks and Kramer (1999) mention the theoretical possibility of international spillovers. They suggest the existence of a 'push' and a 'pull' channel. In short, the 'push' channel puts upward pressure on foreign stock returns. Suppose liquidity growth in country A induces capital outflows towards country B (rest of world). This way, equity prices may increase overseas. These developments could coincide with ameliorated economic prospects in country A and, as a consequence, in the rest of the world. In contrast, the 'pull' channel would depress equity prices overseas. Suppose the liquidity hike in country A gives rise to increasing domestic equity prices and this evolution attracts foreign capital. Provided that the business cycle outlook is only conceived as ameliorated in country A, country B will suffer capital outflow and, thus, depressed equity prices. The evidence, as presented by Baks and Kramer, argues in favor of positive and significant spillovers of excess money growth on real stock returns across G-7 countries. However, in the long run, there appears to be a reversal phenomenon ('neutrality of excess money increase').

Some authors, such as Giese and Tuxen (2007), consider equity and housing prices alike and aggregate these to form an 'asset price variable'.[9] We choose to differentiate between these two types of assets, since we feel there is a significant degree of adhesion between asset classes. First, whereas housing is considered a consumption decision as well as an investment decision (cf. infra), the purchase of stocks is solely an investment decision. Second, the source of funding is mostly different due to the degree of external financing in house acquisitions. In addition, monetary shocks propagate differently throughout the transmission system for shares (Tobin's Q) and housing (direct interest rate effects).

Darius and Radde (2010) argue that the impact of a positive global liquidity shock on equity prices is rather limited and insignificant. This finding is backed by Giese and Tuxen (2007). Belke et al. (2009) report similar findings, even pointing to the absence of stock price increases. Baks and Kramer (1999) argue excess liquidity is positively – but sometimes, insignificantly – correlated with stock returns. This finding, however, stems from their basic correlation analysis, while other mentioned papers make use of VAR approaches. Presumably, evidence of liquidity shocks determining equity prices seems to remain scarce and inconclusive. Therefore, it could be questioned whether the monetary transmission channel accounts for a substantial share of equity price developments and whether other drivers aren't more influential in determining these movements.

### 2.2.2 The impact on housing prices

The transmission of monetary policy shocks to house prices developments has sound theoretical foundations (Mishkin, 2007). Consider an expansionary money supply shock, which drives down short-term interest rates. As a

[9] Giese and Tuxen (2007, page 7) adopt this approach because of data set limitations, although they acknowledge the possible erroneous nature of aggregating housing and equity prices.

consequence, bank lending rates – such as mortgage rates – decrease as well. Since this makes mortgage lending in order to finance house purchases more attractive ('cost of capital' falls), the demand for houses increases. Eventually, house prices are driven up as a response to expansionary monetary policy. Because of the importance of housing to both individual households as to the total economy, this applied 'wealth channel' is considered vital.

Furthermore, the housing market differs from other assets markets because of numerous factors. Mainly, it is argued that the supply of housing is very inelastic in the short and medium run. A positive shock to liquidity – given it boosts demand as well – would then end up inducing strong price increases. Since supply factors ultimately decide prices only in the long run, several economists claim the housing market is prone to bubble-like behavior. These tendencies may be fueled by excess liquidity conditions, which are capable of hiking prices (cf. supra) to potentially unsustainable levels in the medium run (Calverley, 2008).[10]

Moreover, a large number of other factors can possibly cause differences between the response of housing prices to liquidity shocks as compared to other asset classes.[11] The housing market can be described as relatively illiquid, since house owners usually hold on to these assets for a long period of time (residential feature). Also, there is a strong tendency to depend on external debt financing, with real estate servicing as collateral. This makes the housing market specifically prone to changes in monetary policy stances and adverse macro-economic shocks.[12] By the same reasoning, critical de-

[10] Calverley (2008) argues that the recent U.S. housing bubble is partly induced by excess liquidity conditions and surges in mortgage borrowing.

[11] See Hördahl and Pecker (2006) for a more detailed discussion on idiosyncratic housing market characteristics.

[12] Taylor (2007) argues that favorable monetary conditions between 2002 and 2005 (i.e. an inappropriate short-term interest rate path) helped fuel the housing market boom. Reinhart and Rogoff (2009) find that, on average, real housing prices decline by 35 percent following a severe financial crisis.

velopments in the housing market have the ability to affect monetary and economic conditions very strongly. The 2007 subprime crisis – and its aftermath – underlines this argument.

On a global level, these aforementioned explanations may prove to be valid as well. Moreover, the effect could be magnified in a certain number of countries, e.g. due to international spillovers. Therefore, it would be more appropriate to put additional emphasis on global – instead of solely national – house price evolutions. Yet, the prevalence of a global factor explaining housing prices developments remains scarce in most studies. The IMF (2004) estimates roughly 40 percent of domestic price changes can be attributed to global factors.[13] This finding suggests the notion of an internationally-linked housing market is far from a lackluster idea. Theoretically, Belke, Orth and Setzer (2009) see two major motives for this notion. First, the well-evidenced reality of a global business cycle – since housing markets move strongly procyclical – is raised. As a consequence, during a global downfall in economic activity, house prices could consequently plunge in most recession-entering regions. Second, the authors mention the affiliation of the housing sector with globally dispersed securities (e.g. shares). Thus, a stock market crash, which mostly hits financial markets globally, may end up affecting worldwide house prices as well.

We feel an important caveat applies to this line of reasoning. As noticed in the recent economic crisis, a vast amount of countries (e.g. U.K., Ireland, U.S. and Spain) faced severe plunges in real estate prices. Yet in the same period, these movements were not noticed in other developed countries (e.g. Japan and Germany); despite these regions' degree of openness and the high coherence between domestic and world economic activity. This leads us to think that other factors (e.g. national monetary policy and one-way international spill-overs) could be more influential drivers of housing prices.

[13]IMF (2004). "The Global House Price Boom", pg. 84.

Empirically, Darius and Radde (2010) find a significant positive impact of global liquidity on house prices. The upward response of the latter to a positive money supply shock is sluggish, but permanent. More interestingly, they add a *country-specific* medium to their housing prices analysis and extend their model by adding domestic housing price variables. They report that domestic influences generally exercise a stronger influence on housing prices than global liquidity does. This is corroborated by results indicating that domestic, rather than global liquidity factors, are responsible for U.S. house price developments. This finding could suggest that housing prices are more linked with domestic monetary variables than equity and commodity prices are. The authors associate this finding with central bank capability of dampening the effect of rising real estate prices. In that sense, they argue that domestic monetary policy could still be effective in limiting asset price hikes, even in an increased international liquidity environment.

Belke et al. (2009) report a moderate reaction of house prices to a positive liquidity shock, namely that prices increase as soon as the third considered quarter. In comparison with overall prices, the authors find that housing prices react more quickly to a liquidity expansion. This finding is backed by Darius and Radde (2010), who also point out that housing reacts both quicker and stronger than commodity prices.

Theoretically, both the speed and the intensity of housing price developments could be explained by storability considerations (Krugman, 2008). Since houses are more easily stored than commodities and goods, economic agents may find themselves in a more comfortable position when looking to speculate. Suppose the agent expects future output to accelerate, thus driving up housing prices. In order to sell later at better conditions, one could intertemporally substitute supply from the current to the future moment; inducing price increases immediately.

In addition, some authors also note the forecasting content of housing prices for broader inflation measures, indicating house prices might serve as a signaling device.[14]

### 2.2.3 The impact on commodity prices

As things stand, commodity (futures) prices are being closely monitored by central banks, since they are attributed to hold predictive information regarding economic activity and inflation. Moreover, it is also claimed that there is a strong relation between monetary developments and commodity prices (Frankel, 2006; Browne and Cronin, 2007). The impact of global liquidity conditions on commodity prices differs from the housing and equity cases in the sense that there exists a 'world price' for commodities. Contrary to housing and stock prices, where the global figure is the result of a mere aggregation from different countries, commodities such as oil and gold are treated rather homogenously internationally. This differs indeed from other asset prices, e.g. the diverging trends in housing prices in Germany and the U.S. in the past ten years.

The literature is bountiful on both the impact of commodity prices on the economic landscape as well as on possible determinants of oil prices. In contrast, monetary conditions are sometimes overlooked as a possible driver of commodity price developments. Theoretically, we see the relationship between monetary environment and commodity prices as dubious. The debate regarding causality has, to this date, not been settled. To commence, we center on one major work, namely the 'overshooting theory of commodity prices' (Frankel, 1986). This approach uses the same theoretical foundations as 'exchange rate overshooting'. Since commodities are traded on swiftly moving

[14]Goodhart and Hofmann (1999; 2000), for example, find that housing price inflation bears significant forecasting content regarding overall inflation.

trading markets, the response to any market pressure is instant. If a change in the money stock were to occur, commodity prices would proportionally react more than expected, since the prices of consumer goods are in general more sticky. Hence, commodity prices 'overshoot' their long-run equilibrium price. Eventually, these prices will gradually fall back to equilibrium levels. If this assumption were valid, we would expect both a strong and a quick response of commodity prices to (unexpected) liquidity developments with downward pressures existing after the initial reaction.

In contrast, the relationship between monetary policy and commodity price developments is regularly reversed. Essentially, monetary conditions are thus observed to react to commodity shocks, e.g. oil price developments. In this light, it is believed that commodity prices carry essential information for guiding policy strategy regarding output and, especially, inflation. Bernanke et al. (1997) evaluate U.S. business cycles and decompose output effects in two parts, namely one part attributable to an oil price shock and another part to the policy response (in casu, central bank entering a tightening modus in response to an adverse supply shock). They find recessionary elements arise primordially from the monetary response rather than from the initial commodity price shock. The discussion concerning the direction of causality is far from settled and leaves different theoretical avenues open. We restrict our analysis to the response of commodity prices to initial liquidity shocks.

Given the prominence of commodity prices in both monetary theory and applied literature, it appears surprising that empirical research concerning the link between global liquidity and commodity prices is scarce. The relationship between global liquidity and commodity prices has received even less academic awareness than the equity and housing cases did. Belke, Bordon and Hendricks (2009) are the first to disentangle the impact on commodity and other asset prices in the wake of global liquidity shocks. Their findings

are congruent with the view that global liquidity increases spill over to commodity prices. More generally, they note the commodity price developments are significant in explaining broader inflation at a global level. Therefore, they put forth commodity prices as an important forecaster of future inflationary pressures.

Darius and Radde (2010) report the impact of a positive liquidity shock to have a rather sluggish, but permanent effect on commodities. Anzuini, Lombardi and Pagano (2010) corroborate these results, although stating that they find the overall effect of liquidity shocks on commodity prices to be moderate. Belke et al. (2009) underline the sluggish nature of commodity price reactions to liquidity shocks, indicating that the effects arise after nine quarters. An unconventional element of their work is the inclusion of the gold price. They find the latter to react strongly and significantly to positive liquidity shocks.

### 2.2.4 The impact on key macro-economic variables

#### 2.2.4.1 The impact on output

Various transmission channels exist through which monetary decisions can propagate to output developments. Since these transmission processes possibly yield an intermediary role for asset prices, it is worth mentioning issues regarding economic activity and global liquidity.

According to textbook monetary economics, there should be 'long-run neutrality of money'. In other words, a changing money supply ought to have no long run impact on real variables, such as real output. McCandless and Weber (1995) underline this notion. There is however consensus regarding the fact that monetary shocks have significant impact on economic activity in the short and medium run. This notion is linked to the existence of sticky wages and prices, demand-side factors and other explanations.

Theoretically, liquidity expansion in one country can affect foreign output developments in two ways (Rüffer and Stracca, 2006), namely positively (New Open Economy, NOE) or negatively (Mundell-Fleming). As NOE sees it, a positive liquidity shock in country A will cause their exchange rate to depreciate. However, since prices are sticky and we assume the possibility of intertemporal substitution, stronger inflation expectations arise in county A (lower interest rate) and country B (capital inflow). Hence, the real interest rate falls in both countries, inducing a shift from future to current demand (current goods and assets are cheaper relative to future goods and assets).

In contrast, the Mundell-Fleming model doesn't acknowledge the possibility of both countries benefiting from the initial liquidity shock. In their IS-LM-BP framework, accommodative monetary policy in country A will cause the exchange rate to depreciate (capital outflow), transferring demand from foreign products and assets to country A's products and assets.

These considerations tend to grant an insight into the magnitude and duration of a contemporaneous output response to a liquidity shock. This has already been done numerous times, apart from the global liquidity topic (e.g. Peersman and Smets, 2003). We only report the findings of papers which appeal to the global liquidity topic. The main empirical work focusing on the relationship between global liquidity and global output developments is Sousa and Zaghini (2005). They report real GDP to respond positively to an increase in global liquidity; however this result is only present in the short run and tends to disappear thereafter. Additionally, the global liquidity factor poses a significant contribution regarding output volatility from the second year onwards (around 20 per cent).

This evidence is broadly in line with existing single country counterpart work. Therefore, the authors conclude that on the global level, the same kinds of monetary indicators are useable as on the country level. Darius and Radde (2010) report a decline in output after a contractionary money supply shock; as expected. Belke, Orth and Setzer (2009) and Rüffer and Stracca

(2006) find the opposite result after an expansion in liquidity, which backs the previously mentioned evidence.

With regard to international liquidity spillovers, Sousa and Zaghini (2004) point out Euro area output surges in the short and medium run after a global liquidity increase. This development is linked to the liquidity spillover to Euro area M3 (cf. supra). Kim (2001) confirms this spillover argument by finding that a positive U.S. monetary policy shock stimulates both domestic and foreign output. Rüffer and Stracca (2006) run Granger-causality tests and report some evidence pointing in the direction of domestic liquidity spillovers to foreign GDP growth. This evidence is however confined and no geographical pattern is detected. Using a VAR analysis including domestic variables, it appears global liquidity shocks affect broad money and output developments strongly in the Euro area and, to a lesser extent, Japan. Surprisingly, this is not the case for the U.S.

#### 2.2.4.1 The impact on inflation

Notwithstanding the specific focus on asset and commodity prices, it is worth taking a look at the effect on inflation. Basic monetary theory posits that a positive shock to money supply leads to a proportional increase in inflation in the long run (McCandless and Weber, 1995). An increase in money supply is also expected to provoke rising price effects in the short run. This link works through various monetary transmission channels, such as the interest rate channel, the bank lending channel, the balance sheet channel, and many more. Yet, the reaction to liquidity shocks of asset prices and consumer prices ought to be disentangled in order to fully understand the transmission process.

The main difference between asset price inflation and broader inflation (e.g. HICP) focuses on the flexibility of supply-side factors. Whereas most

consumer goods producers can adjust production and supply rather rapidly ('high elasticity of supply'), the quantity of the vast majority of assets is fixed in the short and medium run. As a consequence, if a positive liquidity shock were to occur, the price reaction will be much more outspoken in the assets sector relative to the consumer goods sector (Browne and Cronin, 2007). In the long run, however, supply-side factors are expected to dominate, finally determining prices.

Determining whether liquidity influences either assets or consumer goods more pronouncedly is not straightforward. Hence, the implied risk for price stability is hard to pinpoint. In this light, we refer to the existence of monetary indicators such as money gaps and monetary overhang. One could argue that liquidity hikes do not pose direct risk to inflation since the latter is strongly anchored in developed countries. Moreover, the possibility arises that these developments could have enforced asset prices to rise unsustainably.

In addition, there is a vast collection of literature on the effects of globalization on inflation. Recent work has shed a different light on inflation, claiming that inflation is too often regarded as a national phenomenon. Ciccarelli and Mojon (2005) report that the global factor accounts for 70 per cent of the variance of inflation in 22 OECD countries. Correspondingly, Borio and Filardo (2007) make the case for a global inflation approach. We report the inflation results of various papers which consider the relationship between global liquidity and asset prices. Belke, Bordon and Hendricks (2009) perform a cointegrated VAR analysis and find that global liquidity spills over to global inflation, with commodity prices being an important transmission channel.

Concerning international liquidity spillovers, Sousa and Zaghini (2004) argue a global liquidity increase causes Euro area M3 to hike, and hence, Euro area inflation to rise. In addition, the authors mention global liquidity

as the main driver behind variability of inflation in the long run. This result underlines the possible appropriateness of a global inflation approach.

Furthermore, Sousa and Zaghini (2005) state that global inflation responds positively and significantly after an increase in global liquidity. This trend is strongly noticeable from the sixth quarter onwards. These findings are in line with single country evidence. Belke et al. (2009) come to the same conclusions, including the existence of a time lag. Giese and Tuxen (2007) use a CVAR approach and do find excess liquidity inflationary pressure, as expected. They report this pressure may experience long lags. Lastly, D'Agostino and Surico (2009) report that global liquidity is a superior predictor for future inflation, compared to other predictive methods (e.g. using domestic monetary variables, the estimation of Philips curve models). They also include different measures of inflation to prove robustness, namely CPI, personal consumption expenditures and GDP deflator.

# 3 Data and Methodology

## 3.1 Data

We use quarterly time series ranging from 1990Q1 to 2007Q4 for our global sample, comprising the majority of developed countries (Australia, Canada, Denmark, Hong Kong, Japan, Euro zone, Norway, South Korea, Sweden, Switzerland, United Kingdom and United States) and a vast amount of emerging market economies (China, India, Indonesia, Mexico, South Africa and Thailand). One novelty of this paper, compared to existing literature, is the inclusion of the latter emerging countries.[15] Due to data constraints, a trade-off between sample range and the amount of included countries emanated during the research process. Eventually, we chose to construct a sample which is broad enough to capture all of the relevant dynamics, without having to omit a large number of countries for which data was unavailable.[16] Concerning the global approach, Table 1 depicts the percentage of world GDP which our data set captures for the years 1990, 2000 and 2007, as well as the included countries share. As observed in Table 1, our data set covers approximately 85 per cent of world GDP, which allows us to refer to our constructed aggregates as indeed global.

For each of the included countries, we collect data on real GDP ($Y_t$), Consumer Price Index ($P_t$), the short-term nominal interest rate ($I_t$) and a

[15]The comprising of emerging market economies has often been cited as a fruitful avenue for further research (Souza and Zaghini, 2005), while other papers note that this inclusion – given data limitations concerning these countries – poses constraints on analyzing power (Rüffer and Stracca, 2006).

[16]Because of this decision, a small amount of data was adjusted in order to form the global aggregates (e.g. interpolation of annual to quarterly series for several years). Since this was only necessary for some relatively small economies and only for a limited amount of sample length, these adjustments should present no significant harm to empirical results. The data modifications are mentioned in the data appendix.

measure of money supply ($M_t$).[17] We also assemble data on housing prices ($HPI_t$) for all developed countries. With regard to equity prices and commodity prices, two global indices are included: the MSCI All Country World Index ($MSCI_t$) and the Thomson Reuters Equal Weight Continuous Commodity Index ($COM_t$).[18] Concerning monetary aggregates, we favored selecting the broadest money indicator possible in order to mitigate potential bias effects resulting from different national definitions of broad money.[19] All data are taken from the IMF, the OECD, the World Bank, Datastream and central bank databases and are seasonally adjusted using the X12-ARIMA procedure when necessary.

[17]For some discontinued or incomplete series, comparable variables were used as a substitute (e.g. interbank interest rates when short-term policy rates were missing). These modifications are mentioned in the data appendix.

[18]The MSCI ACWI measures the equity market performance of developed and emerging markets. It consists of 45 country indices comprising 24 developed and 21 emerging market country indices. (MSCI)

The Thomson Reuters Equal Weight CCI is a major barometer of commodity prices. It provides equal exposure to all four commodity subgroups (Energy, Metals, Softs and Agriculture). (Thomson Reuters)

[19]The selected monetary aggregates are mentioned in the data appendix.

Table 1: Percentage of world GDP covered by data set and included countries (in 1990, 2000 and 2007)

| | 1990 | 2000 | 2007 |
|---|---|---|---|
| **Australia** | 1.2 | 1.3 | 1.3 |
| **Canada** | 2.2 | 2.3 | 2.2 |
| **China** | 1.8 | 3.7 | 6.1 |
| **Denmark** | 0.5 | 0.5 | 0.4 |
| **Hong Kong** | 0.5 | 0.5 | 0.6 |
| **India** | 1.1 | 1.4 | 1.9 |
| **Indonesia** | 0.4 | 0.5 | 0.6 |
| **Japan** | 17.0 | 14.5 | 13.0 |
| **Euro area** | 20.7 | 19.4 | 17.9 |
| **Mexico** | 1.7 | 1.8 | 1.7 |
| **Norway** | 0.5 | 0.5 | 0.5 |
| **South Africa** | 0.5 | 0.4 | 0.4 |
| **South Korea** | 1.2 | 1.7 | 1.8 |
| **Sweden** | 0.8 | 0.8 | 0.8 |
| **Switzerland** | 0.9 | 0.8 | 0.7 |
| **Thailand** | 0.3 | 0.4 | 0.4 |
| **United Kingdom** | 4.7 | 4.6 | 4.4 |
| **United States** | 29.0 | 30.7 | 29.2 |
| **Total set** | 85.5 | 85.8 | 84.1 |

Note: GDP figures were retrieved in constant 2000 US Dollar.
Source: World Bank WDI.

In order to form global aggregates, an appropriate aggregation method is vital. As mentioned in section 2, the choice of method poses significant difficulties which are handled differently by various authors. We opt for the three-step approach which is first proposed by Beyer, Doornik, and Hendry (2000) and which has been used frequently in global liquidity papers ever since (cf. supra). First, we calculate yearly weights for each country by measuring the share of a country's real GDP in the total GDP of our data set.[20]

Thus, the weight of a country $i$ at time $t$ is noted as:

$$w_{i,t} = \frac{Y_{i,t}}{Y_{total,t}} \tag{1}$$

[20]We make use of GDP figures in constant 2000 US Dollar (World Bank statistics).

Second, we calculate the quarterly growth rates of any selected series (e.g. money) by applying the formula

$$\Delta M_{i,t} = \frac{M_{i,t} - M_{i,t-1}}{M_{i,t-1}} \tag{2}$$

Then, we multiply the weights calculated above by the individual growth rates of the series. Thus, a 'global growth rate' of the series is developed by aggregating all countries' growth rate 'in global terms':

$$\Delta M_{total,t} = \sum_{i=1}^{I} w_{i,t} \Delta M_{i,t} \tag{3}$$

Finally, aggregate levels are developed by choosing an initial value (i.e. 1990Q1 = 100) and multiplying with the series' global growth rate:

$$indexm_{total,t} = indexm_{total,t-1}.(1 + \Delta M_{total,t}) \tag{4}$$

This aggregation method is applied to real GDP, inflation, money supply and housing prices.[21][22] Concerning interest rates, we multiply a country's interest rate with its weight to acquire a 'global interest rate'.

## 3.2 Methodology

All mentioned papers in section 2 make use of Vector Autoregression analysis (VAR), be it in structural form (SVAR) or in cointegrated form (CVAR).[23] The VAR method allows modeling the effects of exogenous shocks on economic variables, which are all considered endogenous. This VAR approach is justified as it is reasonable to assume that our included variables share a degree of endogeneity. In order to keep our (already complex) eclectic model

[21] It should be noted that – although quarterly data is used – we adopt yearly weights.

[22] In order to construct a housing price aggregate, Individual country weights are recalculated excluding emerging market countries. This is due to the absence of data (cf. supra).

[23] The main difference is that CVAR focuses on a long-run equilibrium relationship between variables, which grants more insight in long-run convergence processes.

straightforward, we follow the SVAR tradition. Since we aim at analyzing mainly the short and medium term effects and econometric results are more easily interpretable when yielded by the SVAR method, the CVAR approach is not essential.

Unit root tests suggest that all series, except for interest rates, are integrated of at least order one. Using unrestricted cointegration rank tests, we find robust evidence of cointegration. Considering these cointegration links, estimating a model using differenced series would present biased estimators due to the deletion of the error-correction term. However, we estimate the model in levels, which should yield asymptotically consistent estimators.[24] As in most reference papers, we do not analyze the long run behavior of the economy. However, since we employ the levels-approach, implicit cointegrating relationships are considered in the data.

We estimate two benchmark models, namely one for asset prices (equity and housing) and one for commodity prices. This modus operandi is motivated by our view that equity and housing prices share a certain amount of similarity (e.g. wealth effects resulting from price changes) and the fact that their price formation is arranged at a national level, while commodity prices are regarded as global. In addition, since our sample is relatively small due to the inclusion of emerging market countries, we feel that estimating the model including all variables could result in a strong loss of degrees of freedom. Nonetheless, this approach is capable of ignoring possible relevant feedback between variables. In order to check for these issues, we split up our asset model specification and estimate two additional models, namely one which only comprises housing prices and another one only comprising equity prices. The results are broadly in line with those stemming from our initial

[24]Similar cases are encountered by Belke, Orth and Setzer (2009) and Darius and Radde (2010). We use the same approach as in these papers, i.e. estimating an SVAR model in levels adopting non-stationary variables. Concerning econometric foundations, we refer to Sims, Stock and Watson (1990).

model, used in this paper. Therefore, we regard our initial specification as unproblematic. It should be mentioned that the inclusion of both assets and commodity variables in one model reduces the significance of the results by a certain extent.

Since the structural VAR model cannot be estimated directly, we need to identify all parameters in the strucutral form from the estimates of the reduced-form VAR. This can be achieved by imposing restrictions on the reduced-form model. We choose to adopt a recursive identification scheme, making use of the Choleski decomposition. However, the use of this method implies certain theoretical assumptions, since the chosen ordering indicates that contemporaneous feedback relations are impeded between certain variables. For the assets model, the corresponding vector of variables is:

$$X_{1t} = [Y_t \; P_t \; HPI_t \; M_t \; I_t \; MSCI_t] \tag{5}$$

By choosing this representation, we thus implicitly make assumptions concering contemporaneous feedback relations. In our view, economic activity ($Y_t$) is fixed in one quarter and responds to innovations in e.g. inflation ($P_t$), housing prices ($HPI_t$), monetary policy ($M_t$ , $I_t$) and stock prices ($MSCI_t$) only with a lag. This represents the concept that monetary policy can affect economic activity, albeit not immediately. The same line of reasoning applies to asset prices, which could, for instance, yield wealth effects, eventually triggering heightened consumption and investment.

Furthermore, output is the only driver of contemporaneous changes in the overall price level. This assumption is in line with basic monetary theory, which states central banks have the ability to adjust the price level using money supply and interest rates, yet only with a certain delay.

Concerning housing prices, we assume that monetary and interest rate shocks do not instantly provoke price effects. The latter are thought of as responsive only after a certain time lag, since, for instance, it takes a certain

amount of time for banks to alter mortgage rates. Eventually, an exogenous change of the central bank stance will affect housing prices – e.g. via bank lending rates – after a particular delay.

Furthermore, we assume that output and inflation have the capability to influence monetary variables contemporaneously. This transmission could take place by means of a change in money demand, which would ultimately result in liquidity and/or interest rate alterations. This mechanism is only presumed to work in a unilateral way since, for instance, output is not affected by central bank decisions in the same quarter. We hereby refer to Sims and Zha (1998), who advocate the usage of the same kind of specifications, claiming that policy makers face information constraints which make instant reaction (e.g. using interest rates) to output and inflation developments impossible. It is argued that reliable figures on the latter are only available with a certain delay, while data concerning money supply is present within the same period. Lastly, equity prices are regarded as responding immediately to changes in all other variables. This assumption is backed by the fact that this financial market variable reacts with immense speed and intensity to developments in e.g. economic activity and monetary policy stances.

The restrictions mentioned above are to a large extent similar to traditions adopted in preceding global liquidity literature (e.g. Sousa and Zaghini, 2005; Belke and Orth, 2007; Belke et al., 2009). Nonetheless, we emphasize that different orderings could also stem from the literature. For instance, Adalid and Detken (2007) and Baumeister, Durinck and Peersman (2008) perform analysis in the field of liquidity shocks and both order the broad monetary aggregate last. This approach insinuates that all other variables have a direct impact on the money stock, while an exogenous liquidity shock affects other variables only after a lag. While the first claim is surely reasonable (for instance, output developments could give rise to changes in money demand, triggering variation in money supply) , the second assumption is

not in line with the theoretical foundation used in this paper.

We argue that this ordering could lead to possible underestimation regarding liquidity decisions of central banks. For instance, the 2009-2010 quantitative easing programmes, as introduced by the U.S. and U.K. central banks, were believed to be partly aimed at short-term equity price effects (Joyce, Lasaosa, Stevens and Tong; 2010). Thus, if exogenous liquidity shocks were assumed to only have lagged effects on equity prices, the desired contemporaneous result of these asset purchasing programmes would have been ignored to some extent. However, it should be noted that our ordering is also susceptible to debate. Since we do not perceive a pure excess liquidity shock (broad money is not ordered last), we lack the guarantee that certain endogenous movements with respect to interest rates and equity prices are excluded.

In the matter of the commodities model, the corresponding vector of variables is depicted as:

$$X_{2t} = [Y_t \; P_t \; M_t \; I_t \; COM_t] \tag{6}$$

As one can notice from the specification for this second model, we maintain the assumptions which were proposed for the assets model. Due to the omission of the asset variables in favor of the commodity price variable ($COM_t$), we only elaborate on hypotheses regarding the latter. The specification of this second model is largely in line with Sousa and Zaghini (2005), who present a consistent rationale for the mentioned restrictions. It is argued that commodities react directly to shifts in output and inflation (e.g. an aggregate demand shock has the capability to directly affect commodity prices, assuming supply is broadly rigid in the short run). In addition, central bank decisions are viewed as also contemporaneously impacting commodities, since the latter are traded on swifly moving trading markets (cf. section 2.4). Additionally, we argue that commodity price shocks can only influence other variables after a certain delay. The reason is that economic acitvity and

inflation are not immediately responsive (e.g. due to capacity constraints and, respectively, price rigidity) when confronted with commodity price developments. The same line of reasoning could be applied to monetary policy responses, since reliable data on inflation is not available in the same quarter.

In both models, a constant is included and all variables are expressed in logs, except for interest rates, which are in levels. Regarding the lag order of the models, we run lag length selection tests (Akaike Information Criterion, Schwarz Information Criterion) and adopt a lag structure of order one for the assets model and a structure of order two for the commodities model. In addition, we run autocorrelation LM tests, which suggest that there is only a limited amount of autocorrelation left in the residuals of both models. Apart from our benchmark VAR analysis, we perform additional VAR tests in order to grant insight into cross-regional effects of global liquidity shocks. These extra tests are based on the benchmark VAR models and are subject to the aforementioned theoretical foundations. Concerning cointegration, lag length selection and autocorrelation issues, similar tests as for the benchmark VARs were performed.[25]

[25]In order to limit the size of this paper, we only present the results of these tests (e.g. cointegration tests) for the benchmark VARs in the data appendix. Additional models are however based on the benchmark VARs.

# 4 Empirical findings

## 4.1 Preliminary correlation analysis

Prior to reporting the VAR results, we perform a basic correlation analysis. This should grant more insight into the nature of included data. Figure 1 depicts the time path of all included series in the VAR analysis. Concerning the development in global liquidity, a significant upward trend is clearly present throughout the whole sample period. In addition, liquidity growth seems to accelerate since 2001. By the end of our sample, is becomes clear that global money supply has more than tripled in eighteen years. Furthermore, the short-term interest rate moves in a dominantly negative trend during a substantial part of the considered period.[26] It is only from 2005 on forth that the world interest rate enters a considerably opposite direction. These findings are largely congruent with the observation that global money supply increased rather strongly during the sample period, and moreover, that it accounts for more than mere money demand accommodation.

The developments in real GDP figures are largely positive. Except for a remarkable slowdown around 2002 [27] , output reveals to have been rising at a substantial pace. Throughout the sample, GDP rose by 70 per cent. As regards the CPI level – a measure of 'global inflation' – we also observe a steady increase during the whole period. By the end of 2007, prices seem to have risen by 60 per cent. However, this upward trend seems to be far from as strong as the evolution in money growth. The difference is for a large part most probably due to accommodating behavior regarding increased money demand, since real GDP moved up too. Nonetheless, we could observe that

[26]The pertinent downward trend in interest rates could be linked to the Great Moderation in developed countries, a period of sustained low, less volatile and more controlled inflation.

[27]This economic downturn might be attributed to the global economic uncertainty around 2001-2002, which was largely due to the 9/11 terrorist attacks, the dot-com bubble and U.S. accounting scandals.

liquidity growth did not transmit entirely into CPI inflation. This intuition emerges from the fact that the evolution in inflation is not yet as strong as one would expect it to be given the global liquidity trend and considering real GDP evolvement. Put differently, a certain share of global money growth is perhaps to be linked with less conventional forms of inflation, i.e. asset and commodity price movements.

Considering the latter, we first observe global housing price developments. The overall trend appears to be strongly positive. For the first half of our sample, price increases remain fairly limited, as the index holds at 140 in 2000. From then onward, an explosive growth in house prices is noticed until 2007, when a sharp reversal takes place.[28] By the end of the studied period, the index has more than doubled. In the case of commodity prices, the trend is less outspoken. A slightly negative and volatile evolution is observed until 2002. From then on, commodities face vigorous price rises during the remainder of the sample. Finally, equity prices are found to be evolving neutrally at the start of our sample. We then observe a strong growth in prices up to the year 2000, when the value of equities starts to show a significant negative trend for a number of years.[29] Equity prices display the firmest increase during the last part of the sample, peaking at a value which is three times higher compared to that of the 1990 starting point.

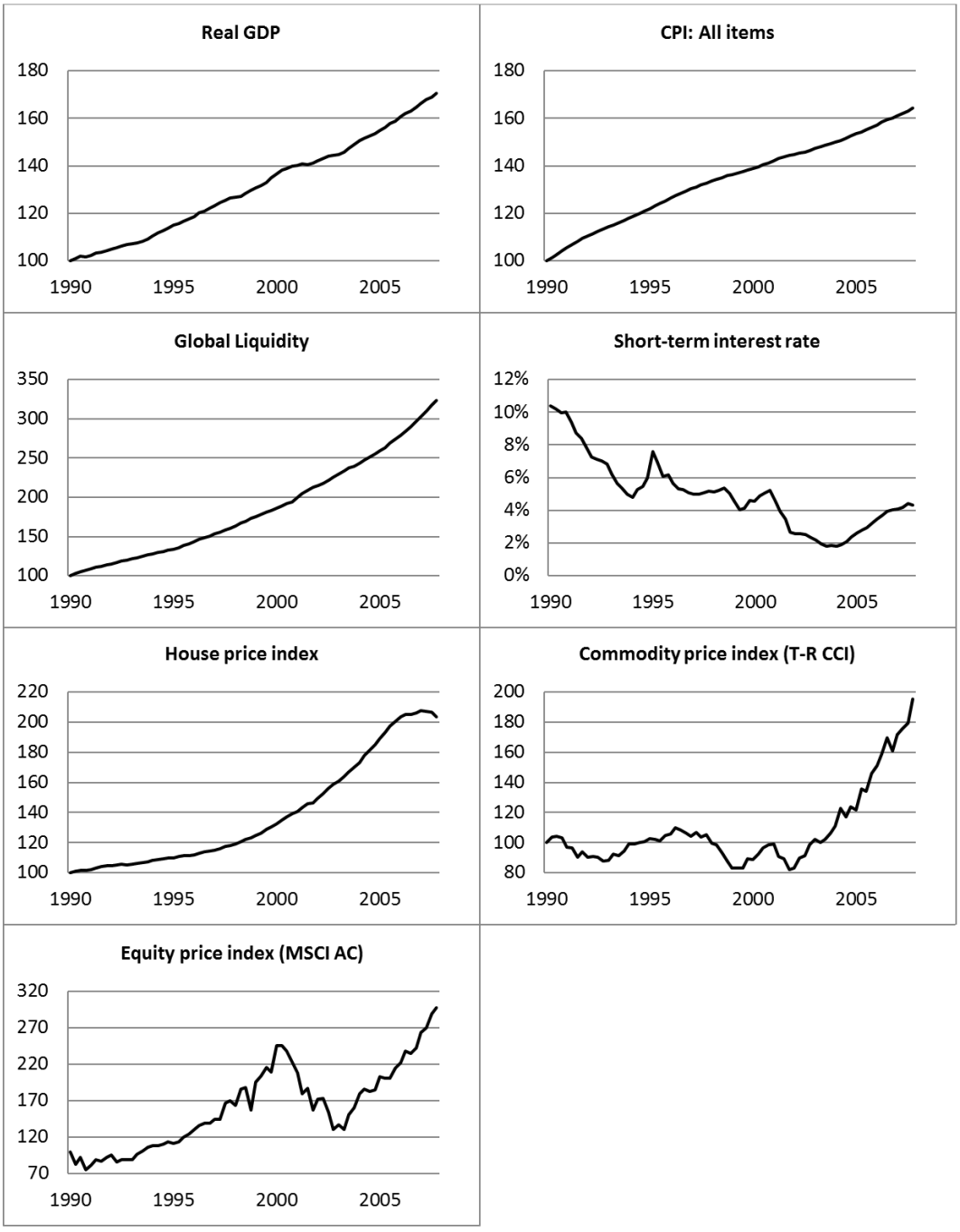
Altogether, the co-movement with the aforementioned liquidity expansion is most strongly noticeable for housing prices, which reveal the toughest and longest lasting price rises throughout the period. Yet, the more volatile path of commodity and equity prices lean less towards obvious correlation patterns with global money supply. It should however be noted that the increase in global liquidity growth which we observed from 2001 onwards could

[28] We associate this with the aforementioned 2007 U.S. subprime crisis and the bursting of the housing market bubble in a number of developed countries.

[29] This negative equity price evolution could be associated with the recession in the early 2000 years, due to the aforementioned reasons (footnote 27).

possibly be associated with the price developments in the commodity and equity markets.

Figure 1: All global series for 1990 to 2007 (index: 1990Q1 = 100)




Note: Index applies to all series except for interest rates. Series are not yet transformed into logs.

To complete this correlation study, we perform an ordinary correlation test using the growth rates of initial data. Table 2 displays the results for housing, equity and commodity prices. Regarding housing prices, we find modest correlation with money growth and output. The most noticeable result is the strong negative link with interest rates. As for commodity prices, we report a moderate degree of interdependence with economic activity and, to a lesser extent, monetary policy variables. A remarkable result is perhaps the low negative correlation between interest rates and commodity prices, hinting at a limited effect of monetary policy on the latter. In the case of equity prices, the most solid connection is found for output. Moreover, the affiliation with monetary policy developments looks to be very limited. Subsequently, we emphasize that these findings stem from a very basic correlation test and should therefore be considered as a mere guideline for more advanced research.

Table 2: Ordinary correlation analysis for housing, commodity and equity prices

| | HPI | COM | MSCI |
|---|---|---|---|
| Y | 0.16 | 0.36 | 0.34 |
| M | 0.17 | 0.22 | 0.07 |
| I | -0.63 | -0.27 | -0.11 |

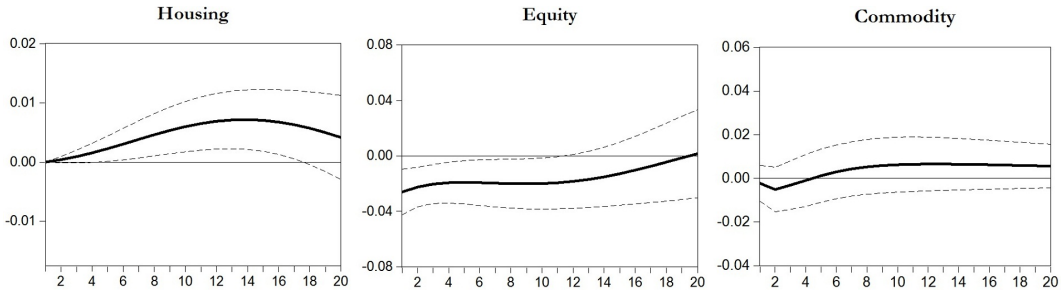
## 4.2 Benchmark VAR results

### 4.2.1 Impulse responses

We proceed by reporting the main findings stemming from the estimated VAR models. Figure 2 reports the response of housing, equity and commodity prices to an increase in global liquidity by one standard deviation for twenty consecutive quarters. In other words, this situation corresponds with

an unexpected, temporary monetary expansion (by 0.3 per cent).

Figure 2: The effects of a positive global liquidity shock




Note: 95% confidence intervals.

As for housing prices, the reaction is sluggish and positive. This price increase persists over the short and medium run and reaches a peak after approximately 3 years. In addition, this effect is deemed statistically significant up to four years after the initial liquidity shock. Moreover, it is not until the fifth consecutive year that a tendency to decrease arises. This finding underlines the assumption that positive global liquidity shocks have the potency to raise house prices over the short and medium term. Moreover, the rather slow response of prices is also found in preceding literature (Belke and Orth, 2007; Belke et al., 2009) and possibly holds resemblance to storability issues and idiosyncratic housing market characteristics (cf. supra).

Pertaining to the intensity of the housing price response, we find evidence on a somewhat moderate price reaction, compared to e.g. Darius and Radde (2010), who report a much more outspoken price increase. This could be due to our inclusion of data on liquidity in emerging markets, whereas Darius and Radde make use of the growth rate of U.S. base money plus international reserves (exchange-based approach, section 2.1). Another possibility for the difference in magnitude might be the construction of the housing price index. In section 4.3, we put additional emphasis on this matter. It should

be mentioned that the magnitude of the price reaction as reported by us, is however strongly in line with Belke and Orth (2007).

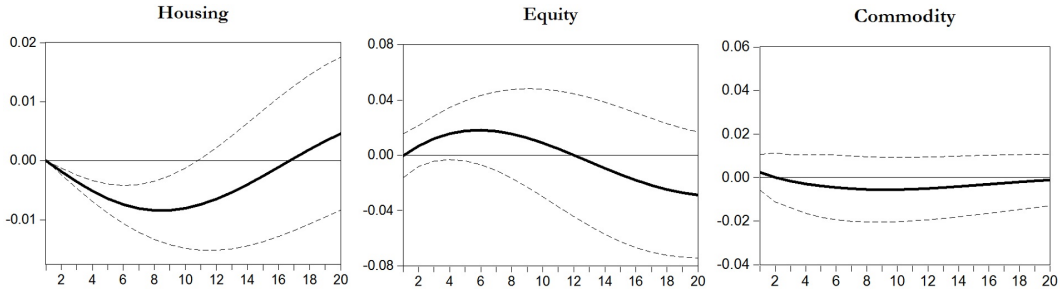
Regarding equity prices, we observe an initial significant and negative response following an expansion in money supply. Equity prices fall initially by two per cent, and this decrease maintains the same magnitude throughout ten quarters. From then on, this effect starts to reverse, thereby losing its significance. As mentioned in section 3.2, we also estimated a model omitting housing prices. The resulting impulse responses are in line with the abovementioned outcomes, confirming these initial findings. Furthermore, this remarkable result seems to counter notions claiming that expansions in money supply boost equity prices via transmission channels (e.g. Tobin's Q). Possibly, other mechanisms than the liquidity stance are the main drivers behind stock prices in the considered sample. In addition, this finding is slightly at odds with prior evidence, which broadly hints at price developments being neutral (Belke et al., 2009) to limitedly positive (Baks and Kramer, 1999; Giese and Tuxen, 2007) following a global liquidity rise.

Concerning commodities, we observe an overall positive, albeit limited price response. It should however be noted that initally, prices fall slightly, an effect which is reversed only after four quarters. From then onwards, a limited and insignificant rise in commodity prices is found, showing a slight tendency to diminish towards the end of the considered period. This 'J-curve' result, as well as the relative persistence of rising price developments in the longer run, is also found by Belke et al. (2009) and Darius and Radde (2010). Moreover, the latter finding could suggest permanent price effects. These observations are somewhat contradictory to the overshooting theory, which suggests a contemporaneous price increase after a positive liquidity shock, with prices subsiding in the longer run.

When comparing the effects of a symmetric global liquidity shock, it is

noticeable that housing prices (four quarters) react faster than commodity prices (six quarters). This observation is in line with evidence from Belke et al. (2009), who associate this difference to the business cycle outlook. Housing prices may react faster since their supply is more inelastic, compared to commodities. It is argued that this is due to the fact that economic prospects are more crucial for commodities than for the housing market, thereby inciting the commodities sector to enhance supply more profoundly, in case liquidity surges coincide with improved business cycle expectations.

Figure 3: The effects of a positive interest rate shock




Note: 95% confidence intervals.

We check whether additional insight emerges from observing impulse responses of equity, housing and commodity prices to a related central bank instrument, namely short-term interest rates. Figure 3 depicts the asset price reactions to a temporary increase in 'global interest rates' by one standard deviation (0.25 per cent), i.e. an environment of monetary tightening.

First of all, we observe that housing prices react in a strongly negative and significant manner to interest rate tightening. This perceived fall in prices seems to stabilize at the eighth quarter, hinting at vast short-run and medium-run effects of interest rate developments to housing prices. After a period of ten quarters, house prices tend to reverse, indicating that long-run effects are largely absent. These findings are widely in line with both existing

theory and empirical work such as Belke and Orth (2007) and Darius and Radde (2010).[30] An explanation for these observations possibly lies in the vital role of interest rates in the housing market (e.g. mortgage rates). As central banks enter a tightening mode, lending rates increase as well, immediately provoking rises in the cost of capital and, thus, depressing demand for housing. In addition, the latter finding could hint at a key role for interest rates – perhaps more crucial than global liquidity conditions – in controlling housing price developments, since we observe the price reaction to interest rates to be both quicker and more profound than the reaction to liquidity shocks.[31] This latter consideration is revisited when analyzing variance decomposition outcomes (cf. infra).

Concerning equity prices, the image is less clear cut. Initially remaining neutral, the price effect grows positive and reaches a peak in the fifth quarter. This rising effect eventually reverses strongly in the medium run. Ultimately, the global value of equities is negatively affected from the third consecutive year on. However, we note that all mentioned developments lack statistical significance. Theoretically, the initially positive price reaction could be deemed somewhat counterintuitive, while also shedding doubt on the role of monetary policy in equity price transmission channels on a global level (cf. the result in Figure 3). Presumably, other mechanisms are more likely to induce movements in global equity prices. Another possible motivation for these contradictions concerns the notion of global equity prices, as captured by the MSCI AC index. Perhaps, the aggregation of national equity price developments provokes certain concerns, since various national stock indices

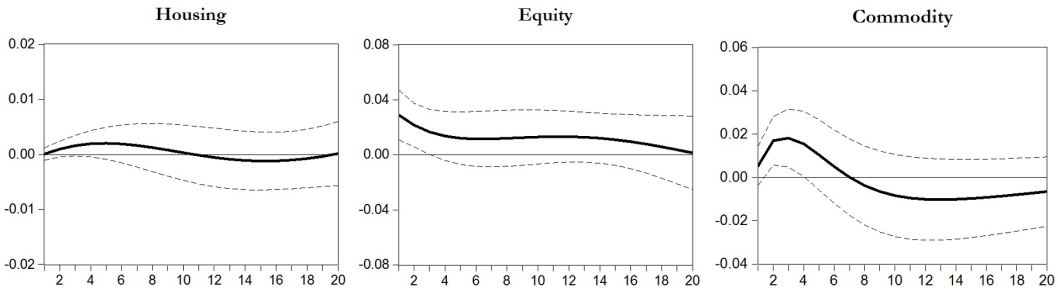
[30] As in the liquidity case, Darius and Radde (2010) constatate a more intense house price reaction following an interest rate shock. The aforementioned remarks apply. Again, our results correspond broadly with those reported by Belke and Orth (2007).

[31] As mentioned in the literature analysis, Taylor (2007) focuses mainly on short-term interest rates in explaining house price developments. Our findings seem to endorse this line of reasoning. However, Darius and Radde (2010) find broadly equal reactions of housing prices to interest rate and liquidity shocks.

did not evolve sufficiently congruent. We further elaborate upon this in section 4.3.

The impact of an interest rate shock to commodity prices turns out to be negative overall, although limited and insignificant throughout five consecutive years. This downward effect is only noticeable from the third quarter on and tends to reverse in the longer run, thereby suggesting permanent price effects are less of an issue in case monetary authorities operate by means of interest rates, instead of the liquidity channel. Our conclusions confirm earlier findings such as reported by Darius and Radde (2010).

Figure 4: The effects of a positive output shock




Note: 95% confidence intervals.

The results discussed above focus purely on monetary developments. Apart from this approach, it may be useful to check how global output developments affect asset and commodity prices. The impulse responses of the latter to a temporary, one-standard deviation shock to global economic activity (by 0.3 per cent) are displayed in Figure 4.

Concerning housing prices, the effect is slightly positive, albeit insignificant for the first ten quarters. From then on, housing prices tend to stabilize. Hence, we find limited evidence to corroborate the relation between a global business cycle and housing price developments (cf. supra). While a rise in

global output seems to increase housing prices somewhat, monetary developments look to account for a much more pronounced effect (see Figures 2-3).

With regard to equity prices, the aforementioned findings appeared to be somewhat counterintuitive. In response, we put forward that perhaps non-monetary evolutions induce for the majority of global equity price movements in our sample period. Our results suggest that a positive output innovation raises equity prices rather strongly, with the upward effect lasting throughout more than four year consecutive years. These findings seem to indicate that global output developments induced a certain amount of equity price evolutions in our sample.

In addition, we also observe positive impact of global economic activity to commodity prices. The detected pattern indicates an inverse U-shaped effect which bears significance in the first four quarters. Initially, commodities face a limited prices increase, in order to reach a peak in the third quarter and fall back again. Eventually, this price response stabilizes towards the end of the mentioned period. These observations are congruent with both the assumption that expectations of heightened economic activity provoke commodity price rises and the overshooting theory (cf. supra). The latter observation gives rise to the hypothesis that, while the overshooting theory seems inconclusive in the case of liquidity shocks, it may be an appealing rationale in the light of output developments.

### 4.2.2 Variance decompositions

Table 3: Forecast error variance decomposition of housing prices

| | (variance due to: ) | | | |
|---|---|---|---|---|
| | Output | Global Liquidity | Interest rate | Housing |
| 1 quarter | 0 | 0 | 0 | 93 |
| 1 year | 4 | 2 | 24 | 60 |
| 2 years | 3 | 8 | 43 | 32 |
| 5 years | 2 | 31 | 35 | 18 |
| 10 years | 17 | 17 | 31 | 16 |

Note: values displayed in percent. Results regarding CPI inflation and equity prices were omitted.

In order to evaluate the relative importance of various shocks to asset and commodity prices, we perform additional analysis by means of forecast error variance compositions. Considering housing prices, Table 3 depicts the contribution of output, monetary policy shocks and the housing component to its forecast error variance. Firstly, global output shocks seem to bear no important explaining power, an observation which could incite one to argue the global business cycle should not receive the most attention in explaining housing price fluctuations in the short and medium run. Secondly, the influence of monetary shocks grows significantly over time. Moreover, interest rate and global liquidity shocks jointly explain over 65 per cent of housing price volatility in a horizon of five years.

We hereby revisit the aforementioned hypothesis of central bank potency in controlling housing price developments. When comparing impulse responses for both liquidity and interest rate shocks, the view emerged that interest rates are possibly a more designated tool as regards to influencing house prices. Additional evidence, stemming from the variance decomposition, seems to support this view. Apart from the fact that interest rates are more explanatory than money aggregates as regards housing price evolutions throughout the considered period, the short rate also appears to affect prices

much faster too. While global liquidity gains significant explanatory power in the longer run, interest rates already account for 24 per cent of the forecast error variances after four quarters. Thirdly, the residual component appears to be largely important in the short term, however losing its influence in the longer run.

Table 4: Forecast error variance decomposition of equity prices

| | (variance due to: ) | | | |
|---|---|---|---|---|
| | Output | Global Liquidity | Interest rate | Equity |
| 1 quarter | 14 | 11 | 0 | 72 |
| 1 year | 12 | 13 | 3 | 70 |
| 2 years | 11 | 17 | 8 | 62 |
| 5 years | 11 | 18 | 16 | 44 |
| 10 years | 11 | 17 | 24 | 37 |

Note: values displayed in percent. Results regarding CPI inflation and housing prices were omitted.

Table 4 illustrates the variance decomposition results for equity prices. While monetary shocks were largely non-explanatory or even counter-intuitively affected equity prices in the above-conducted impulse response analysis, these results are somewhat nuanced given the variance decomposition findings. Firstly, the analysis suggests interest rates are of no meaningful importance, except for the longer horizon. As we recall, the impulse responses hinted at a negative influence of interest rate tightening on the value of equity in the longer run, as suggested by theoretical foundations. Secondly, global liquidity appears to have limited forecasting power throughout the considered period.

These observations imply that it is more meaningful to consider other variables as driving forces behind equity price, as we argued above. In this light, we pointed to a potential role for economic activity, yet output appears to bear only limited explanatory power. Ultimately, the vast amount of fore-

casting power is attributed to the residual equity component, although this becomes less pronounced in the longer run. These observations are perhaps linkable to the nature of equity prices, which are influenced strongly by idiosyncratic and market-specific factors, which are not included in this model.

Table 5: Forecast error variance decomposition of commodity prices

| | (variance due to: ) | | | |
|---|---|---|---|---|
| | Output | Global Liquidity | Interest rate | Commodity |
| 1 quarter | 2 | 0 | 0 | 82 |
| 1 year | 18 | 1 | 0 | 71 |
| 2 years | 12 | 1 | 1 | 76 |
| 5 years | 13 | 4 | 2 | 76 |
| 10 years | 10 | 5 | 2 | 78 |

Note: values displayed in percent. Results regarding CPI inflation were omitted.

We perform the same decomposition analysis regarding commodity prices (Table 5). The most important result is the absence of explanatory power of monetary policy shocks for commodity price developments. Both global liquidity and interest rates seem to lack substantial forecasting power, relative to the residual component and, to a lesser extent, economic activity. Altogether, the importance of the idiosyncratic commodity price component is broadly dominant throughout the while horizon, a finding which puts aforementioned results regarding the capability of monetary variables, in perspective.

## 4.3 Additional analysis

To further evaluate our empirical results, we elaborate on additional, cross-region effects which could be incited by global liquidity developments. The motivation for this approach is twofold. Firstly, certain issues emerged when assessing the impulse responses obtained in section 4.2. These issues pertained primarily to housing and equity price developments following monetary policy shocks. As mentioned above, some results were not entirely in

line with existing evidence or theoretical intuition. In this section, we recall these matters and we elaborate on possible explanations. Secondly, certain 'global liquidity'-relevant topics gained prominence in recent years, which encourages supplementary analysis concerning these subjects (cf. infra).

The emphasis is put on two cases. Firstly, we analyze the cross-country effects of a global liquidity shock to housing prices, namely for the largest economies in our data set: the U.S., the Euro zone and Japan. Secondly, we evaluate whether global liquidity shocks propagate in the same manner for equity markets in developed as in emerging markets. The line of reasoning behind such cross-regional tests is straightforward. Since housing and equity prices are not global in nature, the possibility emerges that global aggregates disguise diverged responses between individual regions. If this assumption were to be valid, a global liquidity shock might provoke asymmetrical price responses in different regions. We address this issue by testing for the existence of international spillovers. Additionally, these tests could be regarded as alternative robustness checks, since we evaluate the responses of asset prices for a large part of our initial data set.

### 4.3.1 Housing: comparing the U.S., Euro zone and Japan

The preceding VAR results in this paper indicate that global liquidity had the strongest effect on housing prices, eliciting much sharper reactions as compared to commodity and equity prices. Possible theoretical foundations for these findings were already given; these include namely elasticity and storability issues and the crucial role of interest rates in mortgage lending transmission. However, in section 4.2, we mentioned that housing price reactions of different magnitude were reported in prior evidence. In response, we linked these differences to the formation of a global housing price index and the accompanying bias in case that the data sets are not composed of the same group of countries. Amongst the three assets analyzed in this paper, housing is arguably the most country-specific asset. During the period

considered in this paper (1990Q1-2007Q4), housing prices revealed no tendency to move in either symmetrical or unidirectional ways.[32] Furthermore, these recent trends in housing prices are regularly linked with both monetary policy stances (Taylor, 2007; Goodhart and Hofmann, 2008) and the global liquidity concept (Belke, Orth and Setzer, 2008).

To assess whether a symmetrical global liquidity shock, as considered in our model, is capable of provoking asymmetrical housing price reactions, we modify the first benchmark VAR model. More specifically, we omit the equity price variable and we introduce individual housing price indices for the three largest economies throughout the sample, namely the U.S. ($HPI_{US,t}$), the Euro zone ($HPI_{EU,t}$) and Japan ($HPI_{JAP,t}$).[33] Hence, the vector of variables for this modified model is as follows:

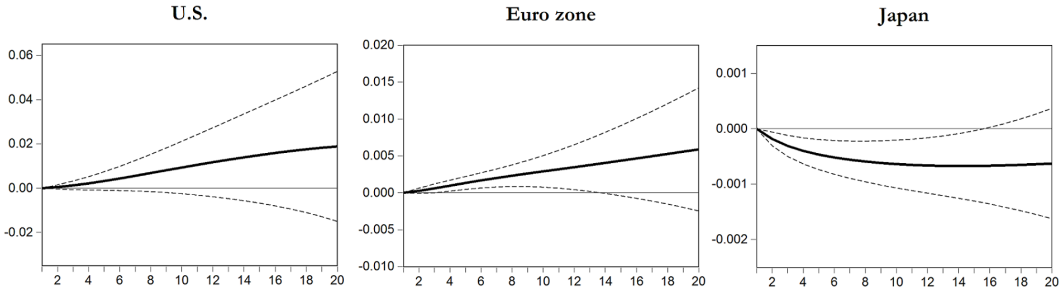
$$X_{3t} = [Y_t \; P_t \; HPI_{US,t} \; HPI_{EU,t} \; HPI_{JAP,t} \; M_t \; I_t] \tag{7}$$

Concerning the Choleski ordering and the accompanying implicit restrictions, the same line of reasoning applies as for the benchmark assets model (section 3.2). In addition, the results appear to be robust for different orderings within the block of housing price indices.

[32] These divergent evolutions between national housing prices are documented by Hott and Monnin (2006) and Kim and Renaud (2008).

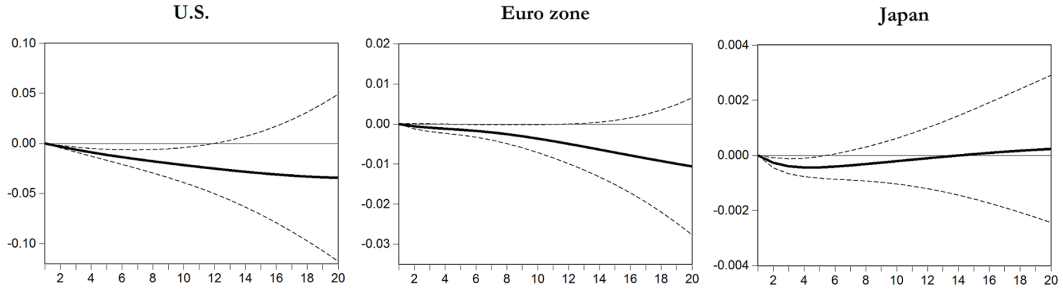
[33] In terms of real GDP, the inclusion of these three countries accounts for 84 per cent of our initially composed housing price variable.

Figure 5: The cross-country effects of a positive global liquidity shock to house prices




Note: 95% confidence intervals.

Figure 6: The cross-country effects of a positive interest rate shock to house prices




Note: 95% confidence intervals.

Impulse response functions for a one-standard deviation shock to global liquidity (0.3 per cent) are shown in Figure 5, with housing price effects depicted for the three individual regions: the United States, the Euro zone and Japan. As for the U.S. and the Euro zone, the effect is sluggish, yet increasingly positive over time.[34] These findings are in line with global analysis, as

[34]Although it seems like these price effects are of permanent nature, there is a reversal tendency when more periods are considered (e.g. 30-40). These long-run effects are not depicted, since we fixed the number of periods in every impulse response function at 20.

conducted in section 4.2. The reaction appears to be the strongest in the U.S., where much more profound house price increases are reported, compared to other considered regions. In the case of Japan, housing value even seems to fall very slightly in response to an increase in global liquidity. This result seems to be at odds with underlying theory, although this finding is backed by Darius and Radde (2010). The timing of the price response seems reasonably equal for all regions.

Given the crucial role of interest rates in housing market developments, we report the impulse responses to a one-standard deviation shock (0.25 per cent) in the 'global interest rate' (Figure 6). The conclusions concerning cross-country differences are largely similar to those regarding liquidity shocks, except for Japan. Indeed, the response of Japanese house prices is now in line with relevant theory suggesting contractionary monetary policy affects housing value negatively. However, as compared to the U.S. and the Euro zone case, the downward price reaction is strongly limited and reverses in the longer run.[35]

How do these results compare with the theoretical foundations (section 2.2.2) and the discussion regarding the magnitude of the price response in other literature (section 4.2)? Firstly, we find only limited evidence regarding the presence of a globally linked housing market (as put forth by Belke, Orth and Setzer (2009)). In this light, we report a certain difference in both the magnitude and the sign of the response of housing prices to liquidity shocks. These observations indicate that other mechanisms, such as national monetary policy, could harbor a higher degree of explanation power than the global liquidity stance.[36] Secondly, we report more outspoken house price

[35]This reversal phenomenon is also noticeable for the U.S. and the Euro zone, albeit after a larger amount of time (cf. supra).

[36]These discussions lie beyond the scope of this paper. For a comparison between both national and global liquidity in determining housing price developments, see Darius and Radde (2010).

increases for the U.S. and, to a lesser extent, the Euro region after a liquidity innovation, compared to the global response as observed in section 4.2. This finding suggests that the difference in magnitude of house price responses can be linked to the particular composition of the housing price index.

### 4.3.2 Equity: do developed markets react differently than emerging markets?

The second additional analysis pertains to equity prices. Similarly to the housing market, equity prices are not formed on a global level. Instead, we made use of the MSCI All Country World Index in order to gauge the influence of global monetary policy shocks onto 'global equity prices'. However, as a fragment of this analysis gave rise to discussable results (section 4.2), we intended to put additional emphasis on this topic. We put forth the possibility that a 'global equity price' notion conceals cross-regional differences in equity market developments. As a consequence, we split up the global sample in two equity price indices, namely one for developed markets and one for emerging markets. This diversification method is commonly used by market indices (MSCI, Dow Jones) and in the literature (Salomons and Grootveld, 2002; Patel, 2008).

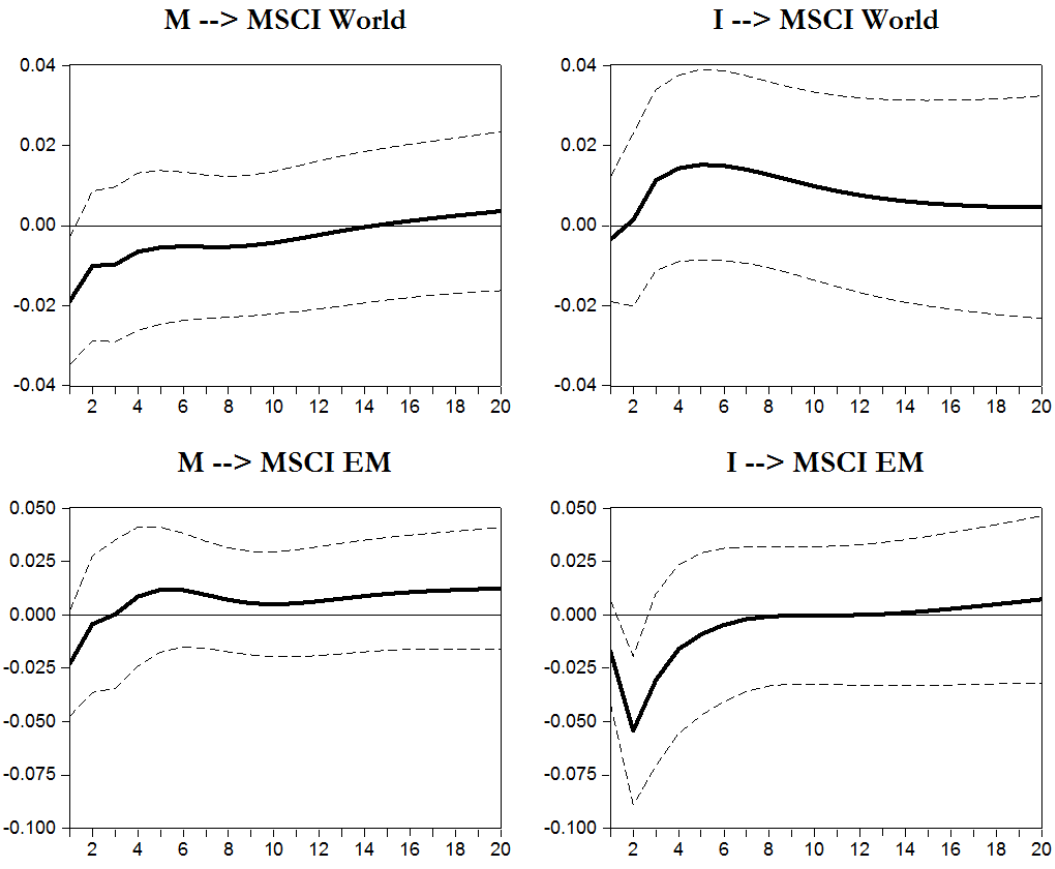
We evaluate whether a symmetrical global liquidity shock enables developed and emerging equity markets to respond differently by transforming the first benchmark VAR model. Specifically, we omit the housing price variable and we replace the global equity price variable by two additional stock market variables, namely the MSCI World Index ($MSCI_{DM,t}$) and the MSCI Emerging Market ($MSCI_{EM,t}$) index.[37] Thus, the model representation becomes:

[37]The MSCI World Index and the MSCI Emerging Market Index measure the equity market performance of respectively developed (24 countries) and emerging markets (21 countries). Jointly, they form the already used MSCI ACWI Index. (MSCI)

$$X_{4t} = [Y_t \; P_t \; M_t \; I_t \; MSCI_{DM,t} \; MSCI_{EM,t}] \tag{8}$$

As to the Choleski ordering and the supplementary implicit restrictions, the same remarks apply as for the previous modified model (4.3.1). Furthermore, the results seem robust for different orderings within the block of equity price variables.

Figure 7: The effects of monetary policy shocks to the MSCI World Index (*developed markets*) and the MSCI EM Index (*emerging markets*)




Note: 95% confidence intervals.

The response of both equity market indices to one-standard deviation shocks in global liquidity (0.3 per cent) and interest rates (0.25 per cent) is displayed in Figure 7. With regard to the developed countries (MSCI World), we observe the equity price reaction to be moderately in line with the results obtained in section 4.2. However, the findings for the emerging markets (MSCI EM) are noticeably contrasting. Concerning the latter, the impulse responses suggest that an unexpected expansion in global liquidity exercises an overall positive effect on equity prices. Although initially responding negative, this effect is quickly reversed and remains positive throughout the sample. In case of a monetary tightening environment, i.e. an increase in the 'global interest rate', the emerging market equity index reacts by initially falling in a strong and quick manner. This effect tends to diminish after six quarters.

Comparing the effects between developed and emerging markets, we find more empirical support of underlying theory concerning the link between monetary policy and equity prices in the case of the emerging markets. One explanation for this finding could be that the aforementioned equity price transmission channels (e.g. Tobins Q, wealth effects) are more responsive in emerging markets, whereas equities in developed markets are less prone to influence from global monetary policy shocks. In addition, these results hint at the possible presence of a 'pull' and a 'push' channel, as discussed by Baks and Kramer (1999). Thus, a rise in global liquidity – as induced by one or more central banks – would then give rise to upward pressure in either domestic or foreign stock returns, considering the nature of the channel. Such assumptions could correspond to the asymmetrical equity price responses observed in this analysis. Although we consider these discussions to be outside the scope of this paper, these findings imply a fruitful avenue for future research.

# 5 Concluding remarks

In this paper, we examined the effects of global liquidity and global monetary policy on housing, equity and commodity prices. This paper attempts to complement the relatively scarce existing literature on the global liquidity topic by means of two novel approaches. Firstly, we introduce data on emerging market countries in our global liquidity measure. To our knowledge, this addition is innovative in the field of global liquidity literature. Our data set captures 85 per cent of global GDP for the 1990-2007 period, designating a truly 'global' approach. Secondly, we pursue an 'eclectic' approach of the topic, maintaining focus on equities, commodities and housing jointly. This method makes a comprehensive comparison of all assets possible.

We adopt the structural VAR method using data from 1990 until 2007 and we estimate two benchmark models, namely one for asset prices and one for commodity prices. Our results indicate the existence of a strong asymmetry in price reactions to global monetary policy shocks. Housing prices are found to respond in a sluggish yet solid manner to both global liquidity and 'global interest rate' shocks. To a much lesser extent, these effects are also present for commodity prices. No such patterns are found in the case of equity prices, implying other drivers than 'global monetary policy' account for their evolutions. In addition, economic activity seems to vastly affect equities and commodities, while housing is only limitedly influenced.

In order to correct for possible cross-country aggregation bias regarding the interpretation of housing and equity price outcomes, we perform an additional spillover analysis. Results for housing prices indicate that the U.S. and, to a small extent, the Euro zone react sharply to global liquidity developments, while Japan remains unaffected. These results provoke a rationale that domestic channels are likewise very determining. As for equity prices, our findings suggest a symmetrical global liquidity shock propagates more profoundly for emerging markets, compared to developed markets. Such

findings hint towards a more straightforward role of equity price transmission channels in emerging markets and the possible existence of 'push' and 'pull' channels.

The two innovations in this paper also yield additional conclusions. Pertaining to the comprising of emerging markets, we find the results to be broadly in line with preceding literature – which only included data on developed markets – although the magnitude of certain price responses varies occasionally. With regard to the eclectic nature of this work, we report a strong degree of asymmetry between housing, equity and commodity price reactions. Therefore, it is argued that elasticity and storability issues, as well as idiosyncratic asset considerations, could be crucially determining in gauging asset price responses to global liquidity developments.

We regard our two innovations as appealing avenues for future research in the global liquidity topic. Due to data constraints, the sample period in this paper is rather limited. As to conducting further analysis, the inclusion of more emerging market countries and the focus on a bigger sample period could yield more insight into the topic. Furthermore, advancing the cross-country analysis should shed more light on the relative importance of global liquidity indicators in impacting asset prices.

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# Data appendix

Table 6: Specification on data sources

| Variable | Definition | Source |
|---|---|---|
| *Monetary aggregates* | Australia: M3 | OECD |
| | Canada: M3 | OECD |
| | China: M2 | OECD |
| | Denmark: M3 | OECD |
| | Hong Kong: M3 | Datastream |
| | India: M3 | OECD |
| | Indonesia: M2 | OECD |
| | Japan: M4 | OECD |
| | Euro area: M3 | OECD |
| | Mexico: M4 | OECD |
| | Norway: M2 | OECD |
| | South Africa: M3 | OECD |
| | South Korea: M3 | OECD |
| | Sweden: M3 | OECD |
| | Switzerland: M3 | OECD |
| | Thailand: M3 | OECD |
| | United Kingdom: M3 | OECD |
| | United States: M2 | OECD |
| *Real GDP and CPI* | Australia, Canada, China, Denmark, Hong Kong, India, Indonesia, Japan, Euro area, Mexico, Norway, South Africa, South Korea, Sweden, Switzerland, Thailand, United Kingdom, United States | OECD, IMF & Datastream |
| *Short-term interest rate* | Australia, Canada, China, Denmark, Hong Kong, India, Indonesia, Japan, Euro area, Mexico, Norway, South Africa, South Korea, Sweden, Switzerland, Thailand, United Kingdom, United States | OECD & IMF |
| | Hong Kong: interbank rate | OECD |
| | Norway: interbank rate | OECD |
| | South Africa: 90-day T-bill | OECD |
| | Sweden: interbank rate | OECD |
| | Thailand: interbank rate | Datastream |

Table 7: Specification on data sources (cont.)

| Variable | Definition | Source |
|---|---|---|
| *Housing* | Australia: HPI Housing Capital cities | Datastream |
| | Canada: HPI | Datastream |
| | Denmark: HPI Family houses & | Datastream |
| | GFSF Housing | Datastream |
| | Euro zone: Residential property price index | Datastream |
| | Japan: CPI Housing | Datastream |
| | Norway: HPI | Datastream |
| | South Korea: HPI Housing | Datastream |
| | Sweden: Real estate price index & HPI Single detached house | Datastream |
| | Switzerland: HPI Single family homes | Datastream |
| | Thailand: HPI Single detached house | Thai central bank |
| | United Kingdom; RPI Housing | Datastream |
| | United States: Case-Shiller index | Datastream |
| *Equity prices* | MSCI All Country World Index, MSCI World index, MSCI Emerging Market Index | Datastream |
| *Commodity prices* | Thomson Reuters Equal Weight Continuous Commodity Index | Datastream |

Table 8: Data modifications

- **Real GDP**
  *China:* Interpolation of yearly data (1990Q1-1991Q4).
  Denmark: 1990Q1 figure is retrieved as a mean of 1990Q2, 1990Q3 and 1990Q4 figures.
  Hong Kong: 2007Q1 and 2007Q2 figures are retrieved as a mean of 2007Q3 and 2007Q4 figures
  India: interpolation of yearly data (1990Q1-1996Q1).
  Indonesia: 1990Q1 figure is retrieved as a mean of 1990Q2, 1990Q3 and 1990Q4 figures.
  Thailand: Interpolation of yearly data (1990Q1-1992Q4). 1993Q1 figure is retrieved as a mean of 1993Q2, 1992Q3 and 1993Q4 figures.
- **Monetary aggregates**
  *China:* 1990Q1 figure retrieved as a mean of 1990Q2, 1990Q3 and 1990Q4 figures.
  *Indonesia:* 1990Q1 figure retrieved as a mean of 1990Q2, 1990Q3 and 1990Q4 figures.
  *Thailand:* 1996Q3, 1996Q4 and 1997Q1 figures were constructed based on yearly trend.
- **Short-term interest rate**
  *Hong Kong:* 1990Q1-1990Q4 figures are interbank rates. 1991Q1-2007Q4 figures are official short-term interest rates (Hong Kong central bank & IMF).
- **House price index**
  *Australia:* all figures are retrieved as an index of house prices in six capital cities.
  *Canada:* 1990Q1-1998Q4 figures are retrieved as mean of house price developments in Vancouver, Montreal and Halifax areas.

Table 9: Unit root tests

| | Y | P | M | I | HPI | COM | MSCI |
|---|---|---|---|---|---|---|---|
| **Levels** | | | | | | | |
| ADF(AIC) | 4.881 | 1.903 | 3.870 | -1.982** | 0.845 | 1.096 | 1.558 |
| ADF(SBC) | 4.881 | 1.768 | 5.649 | -2.103** | 0.768 | 1.096 | 1.558 |
| PP | 14.912 | 9.164 | 26.740 | -2.374** | 5.326 | 1.520 | 1.616 |
| **FD** | | | | | | | |
| ADF (AIC) | -0.626 | -0.968 | 0.167 | -3.989*** | -1.354 | -3.315*** | -1.417 |
| ADF (SBC) | -1.211 | -1.289 | -0.174 | -5.300*** | -1.344 | -3.315*** | -9.841*** |
| PP | -1.459 | -1.258 | -1.226 | -5.361*** | -1.309 | -7.676*** | -9.663*** |
| | | | | | | | |

Note: Asterisks refer to significance level: * = 10%, ** = 5%, *** = 1%.

Table 10: Cointegration test results

Trend assumption: Linear deterministic trend
Series: Y P HPI M I TR MSCIALL
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.544756 | 188.6773 | 125.6154 | 0.0000 |
| At most 1 * | 0.492365 | 134.3798 | 95.75366 | 0.0000 |
| At most 2 * | 0.422550 | 87.59830 | 69.81889 | 0.0010 |
| At most 3 * | 0.284214 | 49.70814 | 47.85613 | 0.0331 |
| At most 4 | 0.222372 | 26.63637 | 29.79707 | 0.1108 |
| At most 5 | 0.087875 | 9.282388 | 15.49471 | 0.3399 |
| At most 6 | 0.041657 | 2.935909 | 3.841466 | 0.0866 |

Trace test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.544756 | 54.29753 | 46.23142 | 0.0057 |
| At most 1 * | 0.492365 | 46.78150 | 40.07757 | 0.0076 |
| At most 2 * | 0.422550 | 37.89016 | 33.87687 | 0.0157 |
| At most 3 | 0.284214 | 23.07177 | 27.58434 | 0.1704 |
| At most 4 | 0.222372 | 17.35398 | 21.13162 | 0.1559 |
| At most 5 | 0.087875 | 6.346479 | 14.26460 | 0.5692 |
| At most 6 | 0.041657 | 2.935909 | 3.841466 | 0.0866 |

Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 11: Lag length selection test results

| | Assets model | | Commodity model | |
|---|---|---|---|---|
| Lag | AIC | SC | AIC | SC |
| 0 | -24.47 | -24.27 | -19.77 | -19.61 |
| 1 | -48.42 | -47.05* | -42.08 | -41.10* |
| 2 | -49.18* | -46.63 | -42.58 | -40.78 |
| 3 | -48.91 | -45.19 | -42.70* | -40.09 |
| 4 | -48.97 | -44.07 | -42.73* | -39.30 |

Note: AIC = Akaike Information Criterion, SC = Schwarz Information Criterion

Table 12: Autocorrelation test results for first benchmark VAR model

| Lags | LM-Stat | Prob |
|---|---|---|
| 1 | 105.5986 | 0.0000 |
| 2 | 41.97351 | 0.2278 |
| 3 | 36.73276 | 0.4347 |
| 4 | 51.16164 | 0.0484 |
| 5 | 60.19735 | 0.0069 |
| 6 | 50.34605 | 0.0567 |
| 7 | 39.06759 | 0.3336 |
| 8 | 44.89130 | 0.1470 |
| 9 | 41.52802 | 0.2424 |
| 10 | 40.64198 | 0.2732 |
| 11 | 35.61967 | 0.4865 |
| 12 | 52.35563 | 0.0383 |

Note: VAR Residual Serial Correlation LM Test

Table 13: Autocorrelation test results for second benchmark VAR model

| Lags | LM-Stat | Prob |
|---|---|---|
| 1 | 33.80319 | 0.1122 |
| 2 | 41.14701 | 0.0222 |
| 3 | 28.80532 | 0.2721 |
| 4 | 36.91642 | 0.0588 |
| 5 | 19.12407 | 0.7911 |
| 6 | 25.40472 | 0.4399 |
| 7 | 17.16244 | 0.8758 |
| 8 | 25.09562 | 0.4570 |
| 9 | 23.48358 | 0.5493 |
| 10 | 20.30673 | 0.7306 |
| 11 | 20.50835 | 0.7197 |
| 12 | 24.32159 | 0.5009 |

Note: VAR Residual Serial Correlation LM Test