Determinants of Global Liquidity Dynamics:a FAVAR approach

Marie-Louise Djigbenou

LAREFI Working Paper
LABORATOIRE D'ANALYSE ET DE RECHERCHE EN ÉCONOMIE ET FINANCE INTERNATIONALES

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LAREFI Working Paper N°2014-04

2014

http://lare-efi.u-bordeaux4.fr

LAREFI
Université de Bordeaux
Bâtiment Recherche Economie – 1er étage
Avenue Léon Duguit – 33 608 Pessac

LAREFI – LABORATOIRE D'ANALYSE ET DE RECHERCHE EN ECONOMIE ET FINANCES INTERNATIONALES

AUTHORS

Marie-Louise Djigbenou, LAREFI, Université Montesquieu Bordeaux IV, Banque de France [1]

NOTICES

[1] The views expressed in this paper are those of the author only and do not necessarily reflect those of the Banque de France. *Marie-Louise.DJIGBENOU@banque-france.fr* I thank Sophie Brana, Bruno Cabrillac, Mathieu Gex, Cameron McLoughlin, Michel Juillard, Dalibor Stevanovic, Sandra Eickmeier, Christiane Baumeister and seminar participants at the Banque de France, the Bank of Korea, the Bank of Canada and participants at the LAREFI seminar and the Canadian Economic Association annual conference for their valuable comments.

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Abstract

Global liquidity, which consists of both monetary liquidity (quantitative easing and traditional policies) and funding liquidity, follows specific dynamics. The importance of these dynamics is reflected by the growing interest in international policy fora in the economic efects and determinants of this phenomenon. This paper contributes to this evolving policy debate by capturing the determinants of global liquidity dynamics. To this end, I employ a Factor-Augmented VAR model, with potential explanatory vari- ables based on Augmented-Taylor rules and private determinants. Using data from 1990 to 2011, I find that the factors representing real activity and financial stability are the main determinants of global liquidity dynamics. The impact of these factors is however heterogeneous across pre and post crisis periods.

Keywords: Global liquidity, Ofcial liquidity, Funding liquidity, Quantitative easing, Monetary policy, Factor Model, Financial stability

1. Introduction

Over recent years, Global liquidity has been one of the main issues in academic and policy debates. Economists, central bankers and international institutions have focused on this subject in order to better understand this concept. This willingness has impulsed many studies. In this context, the Bank of International Settlements (BIS) established for instance an ad-hoc global liquidity working group in 2011[2], having as an output a definition of global liquidity and its measures (CGFS (2011)). According to this report and previous works as the study of Baks and Kramer (1999), global liquidity can be considered as a multifaceted concept which is related to the "ease of financing". It can be approached by both the monetary view and the funding and market view. Traditionally, it is the monetary approach that is used in the literature. This approach refers generally to the official contribution in global liquidity via monetary authorities. Many papers as those of Rüffer and Stracca (2006), DeNicolò and Wiegand (2007) have used this definition of global liquidity. The funding and market liquidity, which concerns the provision of private liquidity, are also increasingly considered in the literature. The paper of Bruno and Shin (2012) reflects this idea by focusing on a cross-border funding via the channel of international banks.

All these works focus essentially on the study of the effects of global liquidity. Baks and Kramer (1999) as well as Darius and Radde (2010) study the spillover effects of Global liquidity on asset prices in order to identify any impact of liquidity on another market. Sousa and Zaghini (2007) focused on the effects on global output and inflation in the G5 economies (United-States (US), Euro area (EA), Japan(JP), United Kingdom(UK) and Canada(CN)), while Brana et al. (2012) analyze the effects on emerging economies. This growing literature highlights the increasingly interest in global liquidity. However, few recent works have analyzed the main drivers of the dynamics of global liquidity. CGFS (2011) outlines the main drivers and some channels of global liquidity but does not

[2] This working group has been chaired by JP Landau, Banque de France deputy-governor.

test empirically these determinants and their impacts in periods of crisis. One of the main contributions of this paper is to study the macroeconomic and financial determinants of global liquidity dynamics and how they impact global liquidity in crisis period according to the respective behaviors of private and official agents.

For achieving this objective, I follow mainly the methodology adopted by Bernanke et al. (2005) which describes a Factor Augmented - Vector Autoregressive (FAVAR) model. This econometric choice is justified by the multifaceted dimension of global liquidity. In fact, the factor model in this method permits to summarize a large number of variables and extract the common factor which is supposed here to be global liquidity. And the VAR approach allows to get the responses to shocks. Based on this econometric method, I used in this paper a large definition of global liquidity which includes both official liquidity and private one proxied here by funding liquidity. Furthermore, as in few recent works, the indicator of global liquidity takes into account not only the liquidity provided by advanced countries but also the liquidity issued by emerging countries. This last part of global liquidity has been neglected for a long time. However it represents almost 40% of the global official liquidity 3(figure 1). Therefore, it is more reflective of the global liquidity to include in the analysis, not only advanced countries, but also emerging ones.

Concerning the potential drivers of global liquidity dynamics, there are extracted from the literature of Augmented Taylor rules and private determinants of liquidity. In accordance with the basic objectives of central banks, inflation and economic conditions are considered as potential determinants. Exchange rates and financial stability objectives are also integrated to the analysis as suggested by the literature and the new approaches of central banks. These factors can also impact the funding liquidity. For instance, as mentioned by Forbes and Warnock (2011) and showed by

[3] In this paper, only the official part of liquidity issued by emerging countries is used for being sure of the capacity of the currency to be used outside its monetary area

Bruno and Shin (2012), the risk or the uncertainty, measured by VIX, plays a significant role in cross-borders flows.

This study considers as advanced countries the G5 economies United-States (US), Euro area (EA), Japan (JP), United Kingdom (UK) and Canada (CN) and as emerging countries Brazil (BR), India (IN), China (CH), Qatar(QA), Saoudi Arabia(SA), Venezuela(VN), Nigeria(NG), United Arab Emirates(UA) for defining global liquidity. The sample covers the period from 1990 to 2011, on a quarterly basis. The potential drivers are extracted only from advanced countries due to lack of data from emerging countries. And a global factor are calculated by potential determinant. This work highlights two main determinants of global liquidity dynamics which are real activity and financial stability factor. The impact of inflation stays mitigate. Moreover, the responses of agents are impacted by the crisis essentially with the rise of uncertainty.

The outline of this paper is as follows: The second section describes the concept of global liquidity and its dynamics. The next section, section III, presents the potential determinants. In section IV, the econometric method of FAVAR model and hypothesis related to this study are detailed. This section also highlights the adequacy of this model with the issue of global liquidity and its determinants. Section V reports the empirical results, while Section VI concludes.

2. Global liquidity dynamics

Even though, the concept of global liquidity could be quiet intuitive, its definition, most of time differs based on the problematic of the study. Three main approaches are however considered in the literature. As the recent paper of Eickmeier et al. (2013), this study integrates the multifaceted definition of global liquidity and emphasizes the role of both advanced and emerging countries in the expansion of global liquidity.

2.1. A multifaceted concept

Global liquidity is a multifaceted concept. It includes the liquidity provided by official and private sectors (CGFS (2011)).

The official view, which is the traditional one, refers to the liquidity provided by monetary authorities. The monetary authorities inject liquidity in the economy by defining the initial conditions of agents refinancing. Traditionally, they cut the main policy interest rates which drives the corridor of interest rates variations. And over the recent period, they adopt unconventional monetary measures such as quantitative easing. By these both policy measures, monetary authorities impulse the dynamics of the liquidity in the domestic economy but also at the world scale. In fact, if the currency of the given country can move easily and be used without many restrictions outside its own monetary area, the liquidity provided by domestic authorities contribute to expand global liquidity. For traditional instruments, as the lowering of key policy rates, the local liquidity is directly spread as for carry-trade strategies, whereas for quantitative easing, the increase of global liquidity pass by the rebalancing of investors portfolio. So, through a direct or an indirect funding of the economy, the monetary authorities policies contribute to increase or decrease the liquidity across the world. And this is particularly relevant with the reduction in barriers to international trade and investment and the development of cross border flows.

This traditional view has been adopted by many economists, who consider both quantitative and price indicators for measuring global liquidity. The price measures are essentially calculated on the basis of key policy rates. It can be a simple average of interest rates of countries considered in the study (GFSR (2010)) or a more complex calculation (De Nicolò and Wiegand (2007)). There are also some price measures based on global real short term in- terest rate and 10 year nominal term premium as shown in the following papers DeNicolò and Wiegand (2007), CGFS (2011), etc. Concerning the quantity indicators, different measures are also presented in the literature. First of all, monetary base is used as reflecting the initial condition of access to liquidity defined by the monetary authorities (Artus (2009)). De Nicolò and Wiegand (2007) and Darius and Radde (2010)

include the base money as a component of global liquidity as CGFS (2011). Other narrow and broader monetary aggregates (M1, M2 or M3) are also cited in the literature. Sousa and Zaghini (2007) define global liquidity in their paper as the "the sum of the monetary aggregates of the US, the euro area, Japan, the UK and Canada" . Another official global liquidity measure, very convenient for emerging countries is the foreign reserves. This part of monetary authorities balance sheet is directly usable for exchanges outside the domestic monetary area. It has been used by Domanski et al. (2011), De Nicolò and Wiegand (2007) and Darius and Radde (2010). All these indicators can be considered for taking into account the impact of monetary policies on global liquidity and highlights the official contribution of global liquidity dynamics. But they do not represent all the liquidity available in the economy. The private sector contributes also significantly to the global liquidity dynamics.

The private liquidity is the liquidity provided by private agents via banking and financial institutions. It consists of funding liquidity and market liquidity which represents respectively " the ease with which agents can obtain funding" and "the ease with which an asset is traded" Brunnermeier and Pedersen (2009). As the official liquidity, funding and market liquidity can also be measured by quantity and price indicators. Concerning quantitative measures, credit aggregates are often used as indicator of funding liquidity (CGFS (2011)). Domanski et al. (2011) consider bank liquidity ratios, maturity mismatch measures and commercial paper volumes. And as price indicator, they suggest Libor-OIS spreads, foreign exchange swap basis, bond -CDS basis or surveys of funding conditions. In a market liquidity perspective, transaction volumes as a quantity measure, as well as Bid-ask spreads on selected global asset, yield differential between less frequently traded and more frequently traded, and qualitative fund manager surveys as a price indicator (De Nicolò and Wiegand (2007), BOE (2007) ,Domanski et al. (2011)) are considered.

As global liquidity is impacted by these different approaches, this study focuses on both official liquidity and private liquidity. Furthermore, because of recent developments on global

liquidity, not only advanced economies are considered, but the liquidity issued by emerging countries is also integrated.

2.2. Advanced and Emerging countries implications

The study of global liquidity dynamics has to integrate the liquidity provided by both advanced and emerging countries, especially with the recent development. In a worldwide perspective, the liquidity created in a country has to be able to move outside its monetary area and used easily in this new environment without a significant lost of its value. In other words, this liquidity or the underlying currency, has to be exportable or useable in a sizeable part of the international trade. According to this criteria, the national liquidity issued by emerging countries has often been neglected. On the private side, the access of foreigners to credit is often limited by regulation, and on the official side the liquidity created by local central banks can be non-convertible. These arguments had justified the focus on only advanced economies. However, considering the assets side of their balance sheet can allow integrating this part of global liquidity.

Emerging countries are now the most foreign reserves holders. Since the end of the 90's with the asian crisis, they have built up more reserves especially for precautionary motives and other motivations. This liquidity, which is directly usable outside their monetary area, reflects also a part of their local monetary policy. Therefore foreign reserves can be used as a proxy of the contribution of emerging countries to global liquidity. Moreover the management of reserves impulses also purchases of foreign risk-free assets in order to reduce the opportunity costs. These acquisitions drive liquidity to another foreign market which becomes more liquid. Thus the integration of foreign reserves from emerging countries is justifying4. This idea is also supported by data.

[4] According to TIC data from US Treasury Department, China stays the most foreign holder of Treasuries in 2011. And this holding represents around 60% of total foreign reserves of PBoC.

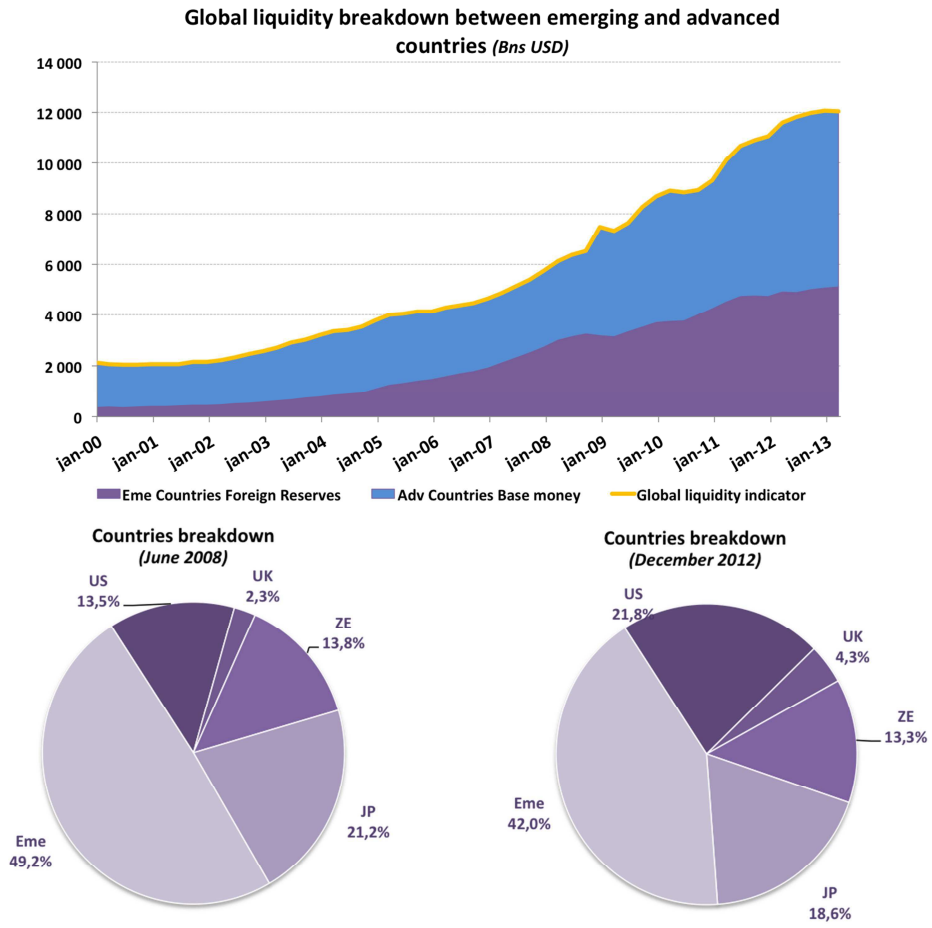
For capturing the share of each group of countries, a global liquidity indicator is constructed on the basis of foreign reserves of emerging countries (Eme5) and Base money of advanced countries (Adv6): figure 1.

This indicator shows a significant contribution of both groups of country. Emerging countries, representing by the main holder of foreign reserves, shares half of the liquidity provided by monetary authorities with the advanced countries in 2008. Their contributions to global liquidity have increased gradually since the end of the 90's and justify the interest for integrating this group of countries in the global liquidity indicators, even though, over recent period, its share has been reduced to 42% due to the liquidity dynamics in advanced countries. The share of the United states has been increasing dramatically due to the implementation of a continuous Quantitative easing policy since 2008. Her contribution has increased from 13,5% in June 2008 to almost 22% of the total in December 2012. The United Kingdom has quasi-doubled her share over this same period, whereas the share of Euro area remained quasi stable, while Japan's share had declined relatively to the rest of the world. This induces a decrease in the weight of emerging countries, which stayed however significant (42%).

[5] Brazil (BR), India(IN), China(CH), Qatar(QA), Saoudi Arabia(SA), Venezuela(VN), Nigeria(NG), United Arab Emirates(UA)

[6] United-States (US), United Kingdom(UK), Japan (JP), Euro Area (EA), Canada (CA)

Figure 1: Breakdown of global liquidity between Advanced and Emerging countries



For a more robust and complete description of the dynamics of global liquidity, different indicators are being constructed.

2.3. Development of global liquidity

As mentioned earlier, global liquidity in this paper is defined by both its public and its private components. The liquidity provided by monetary authorities is measured by key policy rates and monetary base for the advanced countries (US, UK, JP, EA, CN) and by foreign reserves for the emerging countries (BR, IN, CH, QA, SA, VN, NG, UA). For a longer period empirical analyse, only credit and short term interest rates (3-months and 6-months interbank rates) are considered as a measure of private liquidity. Moreover, the combination of both official indicators and credit permits

to get a better view of the dynamics of global liquidity. The interest of that considerations could be for instance to monetary authorities to better focus their monetary decision on improving the financial stability. These relationship have been studied by Christiano et al. (2011). The authors conclude in their paper that a greater role of credit growth in the interest rate targeting rule would moderate the volatility in the real economy and in asset prices, and therefore would improve the financial stability.

I consider also narrow and broader monetary aggregates M1 and M2. These indicators integrate de facto the actual monetary policy and reflect also the credit distribution.

All these indicators are extracted from Central banks, IFS, WEO, OECD, Reuters databases and other national sources from 1990 to 2012. For quantitative indicator, I follow the calculation method proposed by Baks and Kramer (1999) which consists in expressing each domestic indicator in terms of local GDP, then to weight them by their relative GDP in terms of PPP. Concerning the price measures, the global liquidity indicator is obtained by a simple average of national interest rates.

On the whole, until 2008, the indicators of global liquidity in figure 2 reports an upward trend of global liquidity. In spite of some episodes of rate rises, the policies adopted by monetary authorities have been wholly accommodative and credit has continued to grow. The cut of key policy rate following the NTIC crisis in 2001 has permitted to inject liquidity inside the economy until 2004. The credit, slowed-down by the crisis, is relaunched after the monetary policy actions. So in 2004, the global liquidity is sustained by both monetary policy and by private sectors. To keep downing these dynamics, the monetary authorities increased their key policy rate which passed in average from 2,3% in March 2004 at 4% in September 2007. This increase is reflected through the monetary base volume which stayed quasi constant over this period. On the contrary of this restrictive policy, the credit continues to grow on that period.

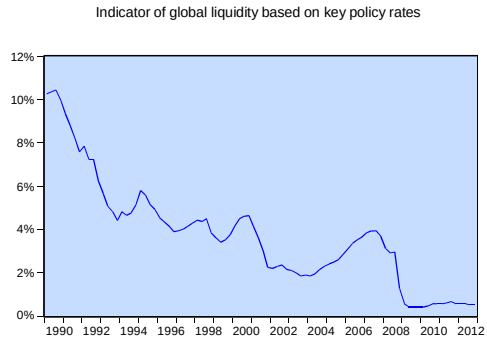
With the beginning of the crisis in 2007, started first series of lowering interest rates. These rates passed from 3,90 to 2,95% in september 2008. But with the crisis worsening, other plans have

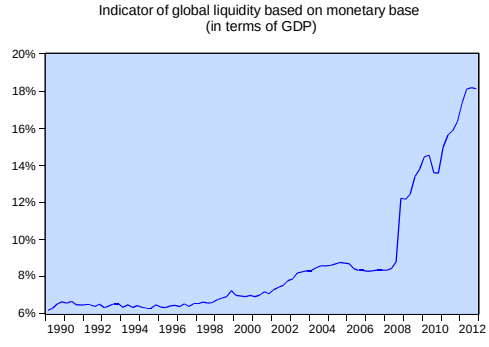
been implemented, leading the rate close to zero in september 2009. This substantial decline is followed by a dramatically increases in monetary base which continues to grow with the implementation of unconventional monetary policy (quantitative easing, credit easing, etc.) although the interest rate remained close to zero. On the side of private liquidity, the sustained growth of credit in terms of GDP is interrupted in 2009 and is declining. Therefore the ample liquidity provided by monetary authorities is implemented in a context of weak and unstable private liquidity.

The monetary aggregates M1 and M2 follow the dynamics of monetary policy but integrate information from private sector too by slowdowns in 2009. For emerging countries, the part of foreign reserves in terms of GDP has continued to grow since the 1990's until September 2008. After a short decrease, the build up of reserve start again but with a lower speed.

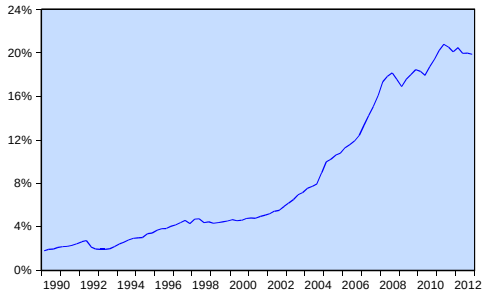
All these indicators are so useful for understanding the dynamics of global liquidity. The monetary base as a quantity measure permits to take into account the non-conventional mea- sure which are not reflected in interest rate data, especially with zero lower bound. In addition many configurations can be considered according to the policy adopted by monetary authority and the dynamics of private liquidity. For studying the macroeconomics and financial factors behind this dynamics, it can be interesting to focus on the determinants of each component.

Figure 2 : Global liquidity indicators

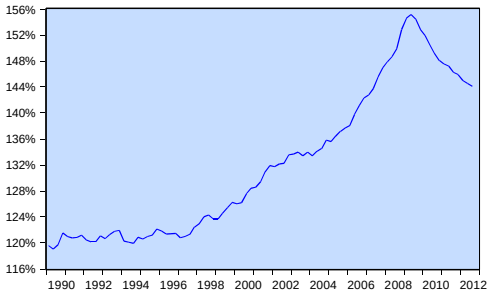




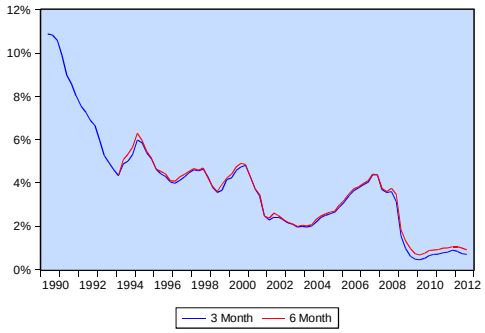
Indicator of global liquidity based on foreign reserves
(in terms of GDP)



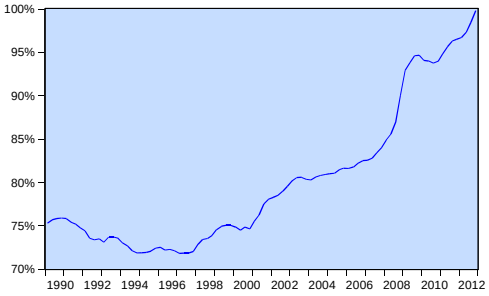
Indicator of global liquidity based on private sector credit
(in terms of GDP)



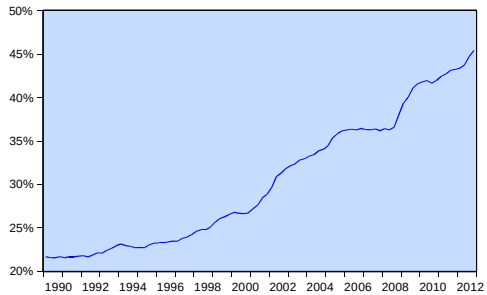
Three and Six month global interbank rates



Indicator of global liquidity based on broad monetary aggregate
(in terms of GDP)



Indicator of global liquidity based on monetary aggregate M1
(in terms of GDP)



3. Potential determinants of global liquidity

Determinants of global liquidity are defined in terms of macroeconomic and financial factors which drive the monetary policy and the dynamics of private liquidity proxied in this paper by funding liquidity or by credit. Concerning the determinants of monetary policy, the price stability is the main objective of monetary authorities. In accordance with the experience of monetary authorities, a broad consensus arose from the central banks and the economists around the priority to price stability 7. The control of inflation permits to guide the evolution of purchase power in the economy and therefore fosters an environment conducive to economic growth. Central banks also consider as another objective the economic growth. This second objective is most of the time combined with the inflation controlled in a Taylor rule according to the preferences of monetary authorities. These two objectives are the traditional objectives chosen by almost all central banks. But other objectives can also be enumerated in the macroeconomic determinants of monetary decisions.

The financial stability and the exchange rates have also be raised as potential factors which drive monetary policy. In spite of the debate around the integration of asset prices in the monetary policy, some central banks have already integrated this variable in their decision. For instance, the Bank of Canada outlines: “as made clear in the past, to the extent that financial imbalances affect the near-term outlook for output and inflation, financial stability considerations are already taken into account in the setting of monetary policy ”. And more recently, the Canadian monetary authorities have considered also integrating some flexibility due to financial stability in its inflation-targeting agreement. This choice of taking into account financial stability is essentially based on the capacity of asset prices to help forecasting the output and to some extent the inflation. Cecchetti et al. (2000) find also in their paper that taking into account the asset prices in the monetary policy improve the monetary policy and can reduce the output volatility, those which satisfies the traditional and main objective of central banks. Moreover the "Great deviation" 8, observed over recent years, which describes the gap between the observed and the Taylor rule rates, could suggest other factors in the

[7] Friedman (1982) “there is today a worldwide consensus, not only among most academic economists but also among monetary partitioner, that the long-run objective of monetary policy must be price stability»
[8] Taylor (2011)

rule of central banks. Hofmann and Bogdanova (2012) show also this deviation and explain it by different potential factors, and particularly the asset prices and the exchange rates. Taking into consideration the exchange rates in monetary decision can be justified by the willing to keep a quite stable differential rates with other monetary areas in order to limit the unwelcome capital inflows. Therefore, inflation, economic activity, financial stability and exchange rates could be determinants of global liquidity.

Concerning the private sector, these previous variables can also be considered as determinants of private liquidity. Hofmann (2004) studies the determinants of private sector credit and justifies a role of real activity and real estate prices in the dynamics of credit. The real activity impacts both the demand and the supply side of credit. Households and firms define their demand of credit according to current and expectation of economic activity dynamics. And if the expectations are less beneficial, the demand of credit can be reduced because agents want to be able to pay off principal and interests of the loans. As the dynamics of economic activity induce the degree of creditworthiness, the suppliers are also more reticent to lend. The role of real estate is linked to wealth effect on the demand and the value of collateral required for getting a loan. So asset prices and economic activity could be also used as macroeconomic factors of private liquidity. Inflation impacts by definition the real interest rates. And the effects of exchange rates dynamics are integrated in carry trade strategies which also impact the dynamics of credit and private liquidity. Empirical studies as those of Hoffmann (2012) and Clarida et al. (1998) have already highlighted respectively this taking into account of exchange rates in the monetary decision of ECB and in Bank of Japan.

Therefore, economic activity, inflation, exchange rates and financial stability could be considered as potential determinants of global liquidity either by official part or by private. Some researches also show an asymmetric reactions of some central banks to the volatility of asset prices (VIX). D'Agostino et al. (2005) find that the reaction of the Federal Reserve (FED) de- pends of the volatility regime of asset returns, with a more significant reaction during period of falls. This result is also showed by Sİüren (2012) and Hoffmann (2012).

One of the main interests of this paper is, on the one hand, to study if these relations are observed empirically in a larger global liquidity approach which focuses on the two components of

global liquidity and in a global perspective, and on the other hand, analyze if the behavior of these determinants have changed with the financial crises of 2008. As these studies require a huge number of variables for the definition of concepts and applied to different countries, a Factor augmented-autoregressive vector (FAVAR) model is adopted.

4. FAVAR Model and Hypotheses

4.1 Methodology and Justification of FAVAR approach

This approach has been proposed by Bernanke, Boivin and Eliasz (2005) and combines a Factor model with structural vector auto-regressive (SVARs) methodology. This econometric method permits to integrate in only one model a rich environment of informations by factor approach.

According to Stock & Watson (2002, 2005) and Forni, Giannone, Lippi & Reichlin (2009) works, I consider that each variable X_{it} has two components linked by a linear relation :

- A common component χ_{it}
- An idiosyncratic component ξ_{it}

By this way,

$$X_{it} = \chi_{it} + \xi_{it}$$

I consider also that common components are driven by q macro-shocks u_t, which are a linear combination of Factor F_t

$$\chi_{it} = B_n(L).u_t$$
$$F_t = N(L)u_t$$

such as $B_n(L) = A_n N(L)$.

Therefore initial variables can be expressed by the following relation:

$$X_{it} = A_n.F_t + \xi_{it} \quad (1)$$

By this factor equation, more informations known by agents in the economy are put in the model. So an economic concept can be better described by a set of variables due to common

macroeconomic component captured in the model. And Principal component analysis is suitable as method for achieving it. Applied to Global liquidity, this econometric method allows to summarize the information contained in the diferent approaches of the concept, and by this way getting a more efective representation of global liquidity. As mentioned earlier, the global liquidity depends on both the ofcial and the funding liquidity. So the liquidity available in a global perspective could be considered as the common factor resulting from dynamics of its components.

Another benefit of Factor model is to make easier the identification of shocks. In fact, adding more information in the model reduces the risk of getting a wrong shock especially for structural VARs model. In other words, it reduces the unfundamentalness risk (Forni, Giannone, Lippi & Reichlin (2009)) and improves the model explanatory power. According to factor equation (1), expression of VARs becomes:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) * \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \nu_t \tag{2}$$

From this second equation (2), the efects of macroeconomic shocks can be assessed. These variables can be extracted from factor equation F_t or can be directly observable variables Y_t. The FAVAR Model is therefore represented by the following relations (Bernanke, Boivin & Eliazs (2005)):

$$\begin{cases} X_t = \Lambda F_t + e_t \\ \begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \Phi(L) * \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \nu_t \end{cases} \tag{3}$$

Therefore, FAVAR model allows us to get a Factor measure of Global liquidity which capture both dynamics of ofcial and funding liquidity. Moreover, it permits to measure the efects of potential determinants on Global liquidity factor by impulsing response functions and study- ing the direction of causality via Granger causality test. I am also interested by the Variance decomposition, which gives an indication on the explanatory ability of the determinants. But in order to do so efectively, it's necessary to define a structure of the model by identification schemes.

4.2 Identification schemes

The identification schemes concern both the identification of factors and the identification of shocks. The idea underlying the identification of factors is to guarantee the structure of the factor and in this paper, to get an economic meaning essential to the interpretation of the factor. As the derived factors issued from the principal component analysis will be afterwards put into a VAR model, the number of factors is restricted to 1. This hypothesis seems not so strong for the explanation power of factors in the main estimation is greater than 30% and the factor of global liquidity is more than 45%.

To keep an economic meaning to economic concept used in this FAVAR model, some restrictions are introduced into the loading matrix (the matrix of the coefficients), as done by Belviso & Milani (2006). The restrictions are described just below with X_i a subset of the whole sample which shared the same economic meaning and F_i the related factor.

$$\begin{bmatrix} X_t^1 \\ X_t^2 \\ \vdots \\ X_t^I \end{bmatrix} = \begin{bmatrix} \Lambda_1^f & 0 & \dots & 0 \\ 0 & \Lambda_2^f & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \Lambda_I^f \end{bmatrix} \cdot \begin{bmatrix} F_t^1 \\ F_t^2 \\ \vdots \\ F_t^I \end{bmatrix} + e_t \qquad (4)$$

The subsets series Xi are ordered as required by the Cholesky decomposition for defining a structure of the model. This ordering permits to identify the effect of each chock instead of the effect of a combination of chocks issued from a regression without restrictions. The structure of the model retained here considers the global liquidity indicator as the most endogenous variable according to the “augmented Taylor-rules” presented in the above section. As justified earlier, the dynamics of liquidity could be driven by real activity, inflation, exchange rates and financial stability. Among these variables, exchange rate is considered as the most exogenous, because it results from the decision of many authorities and therefore is less controllable than the local variables. This view is also shared by Darius and Radde (2010), as many other studies who consider also that “output

contemporaneously affects inflation". In fact, the general price in the economy are more sensitive to actual and expected output. Agents adjust more quickly the price than the dynamics of the economic. And this pace of adjustment in prices is even more suitable on financial markets where agents integrates directly the information in their price. Therefore the following order will be adopted :

$$\begin{bmatrix} X_t^{er} \\ X_t^{gdp} \\ X_t^{cpi} \\ X_t^{fstab} \\ X_t^{gli} \end{bmatrix} = \begin{bmatrix} \Lambda_{er}^f & 0 & 0 & 0 & 0 \\ 0 & \Lambda_{gdp}^f & 0 & 0 & 0 \\ 0 & 0 & \Lambda_{cpi}^f & 0 & 0 \\ 0 & 0 & 0 & \Lambda_{fstab}^f & 0 \\ 0 & 0 & 0 & 0 & \Lambda_{gli}^f \end{bmatrix} . \begin{bmatrix} F_t^{er} \\ F_t^{gdp} \\ F_t^{cpi} \\ F_t^{fstab} \\ F_t^{gli} \end{bmatrix} + e_t \quad (5)$$

Each subset of variables organized by economic meaning is identified as highlighted by the table 1.

5. Empirical application

5.1.Data

Table 1: Description of economic concepts

Economic concepts and its components	
Factor **Exchange rate** : F^{er}	Bilateral exchange rate against USD
Factor **Real activity** : F^{gdp}	Consumption GFCF Government consumption Industrial Production Real GDP Unemployment rate Imports and Exports
Factor **Inflation** : F^{cpi}	Consumption Price index
Factor **Financial stability** : F^{fstab}	House Prices Stock exchange VIX
Factor **global liquidity indicator**: F^{gli}	Global indicator based on Monetary base Global indicator of Foreign reserves Global indicator of key central banks interest rate Global indicator of narrow monetary aggregate M1 Global indicator of broad monetary aggregate M2 Global indicator of Credit to private sector

(UK), Euro Area (EA) and Canada (CAN). Concerning Euro area, proxies will be gotten by data from Germany, France, Italy and Spain if data are not available. Data are on quarterly frequency from 1990 to 2011 and make stationary.

Based on Principal components analysis, Factors are gotten. Two loadings matrix will be calculated for Global liquidity according to the reference period. I distinguish a pre-crisis period from 1990 to 2007 and the whole sample covering the crisis (1990 to 2011).

On the period prior crisis, the main components of Global liquidity factor are monetary liquidity aggregates which integrate the transmission of official liquidity to real economy and the weight of key policy rate stays significant. This is relatively close to reality before crisis. The policy rate was the principal instrument of central banks for impacting liquidity and transmission channels were sufficiently effective. So I can emphasize these components.

But after the crisis, monetary authorities widen their policy instruments and monetary base fluctuates dramatically. The funding liquidity via credit is monitoring closely for avoiding credit

crunch. On the side of emerging markets, the foreign reserve weight on global liquidity decrease relatively to previous period.

For real activity factor, the signs of components are consistent with the economic meaning. In other words, an increase in this factor implies a greater consumption, investment or a decrease in unemployment rate. This principal is applied to all potential determinant factor. The international trade factor measures the growing of exchange between countries, that is an increase of both imports and exports.

5.2 Determinants of global liquidity

Real activity, the main driver of global liquidity

Global liquidity is mainly driven by economic activity, which explains almost one third of the forecast error variance. This result is consistent with the priorities of central banks and the high weight of economic background in the distribution of credit. In fact, in absence of high inflation as observed during the pre-crisis period, monetary authorities support eco- nomic activity by also limiting the risk of overheating. The global improvement of economic performances until 2008 can therefore contribute to justifying some restrictive measures imple- mented by monetary authorities as in 2004 and 2005. This reflects the negative and significant relationship between real activity and official liquidity shown by figure 6. These monetary policies are integrated in the determination of funding liquidity as suggested by figure 8 and 10. Private agents in this situation face less favorable financing conditions (figure 7), which reduces the private liquidity. So as the whole, the first impact of the economic expansion is a slowdown of global liquidity due to action of monetary authorities (figure 4). However, this effect is not permanent. In the following months, financial institutions dampen progressively the monetary constraints and renew with providing increasing funding to the economy in order to benefit from the growth. Thus increases global liquidity.

Over the recent period with the great recession, the relationship between official and private agents, real activity and global liquidity stays, on the whole, suitable. Monetary authorities impulse the dynamics of liquidity and issue liquidity.Nevertheless, contrary to the growth situation, the reactions of central banks are greater than in the previous case (figure 5). In fact, they have to inject

more liquidity in the economy in order to contribute to restoring the economy, and offsetting the lack of private liquidity. Private agents, in this crisis context, are more reluctant to loan and become very pessimistic about the recovery of the economy (figure 9). The accommodative stance of monetary authorities impacts shortly the behavior of financial agents who continue to tighten significantly the funding in the economy. Con- sequently, the actions of central banks have to be strong enough to successfully fund the economy directly. This result justifies the reactions of official agents during the crisis and the non-conventional measures implemented. Quantitative easing and credit easing, which have been widely used, have helped provide funds directly to specific markets or agents and compensating the lack of funding liquidity.

So, depending on the economic situation, official and private agents do not have the same role in the provision of global liquidity according to the economic situation. In period of growth, the banks and other financial institutions are the main issuer of liquidity, and central banks try to contain the liquidity dynamics. But during period of recession, these private agents overshoot compare to the growth framework and reduce considerably the liquidity. In that context, monetary authorities increase dramatically the official liquidity and become a stronger and more strategic player. Therefore, the dynamics of global liquidity depend on economic situation, but also on financial stability.

Financial instability and heterogeneities across agents

Financial stability is the second main determinant of global liquidity according to variance decomposition (figure 11). As defined previously, the financial stability indicator is calculated by taking into account asset prices especially equity and real estate indexes as well as a measure of uncertainty on financial market, the VIX. An increase of this indicator match with higher asset returns and lower financial uncertainty.

The results of this study suggest that there is a negative significant relationship between the indicator of financial stability and global liquidity (figure 4 and 3). As for real activity, monetary authorities react contra-cyclicaly. In period of boom, they slowdown the growth of liquidity, especially the market liquidity, which by definition increases dramatically with lower volatility on

markets or higher asset prices. However, this action of monetary authorities seems to have just a short and small impact on the distribution of credit (figure9). Banks integrate the constraints of monetary authorities but provide credit few quarters later as the financial stability reduces the risk of insolvency. Nevertheless, the impact of financial stability on the distribution of credit seems limited as highlighted by figure 11 and the corresponding IRF, contrary to period of stress.

In period of financial instability, as on the recent period, with higher volatility and frozen markets, market liquidity is strongly degraded, weak or nearly inexistent in some markets. Monetary authority react by injecting liquidity for limiting the transmission to the real econ- omy. This accommodative monetary policy is marginally integrated by the banks. However, unlike to period of boom where banks have almost neutral stance, these agents in period of higher uncertainty react significantly by decreasing the volume of credit. This could be as a result of lower demand or supply of credit . But whatever the source, the better funding conditions impulsed by monetary authority does not restore the credit.

This result is emphasized by the variance decomposition (figure 11) where the heterogeneities across agents behaviors are very well highlighted. During period of boom, the share of financial stability for explaining credit does not exceed 10% of the variance of the forecast error, whereas after the crisis, it double and represent 20% at the same horizon. For monetary authorities, they are more concerned with avoiding or limiting the formation of bubbles than responding actively in case of crisis. The impact of financial instability on the official liquidity is lower than the response of monetary authority to financial stability. In average, before the 2007 crisis, financial stability represented 15% of the variance of official liquidity and after the crisis this figure decrease at 6. This result is consistent with the willingness of central banks to limit moral hazard which could follow an extensive involvement of monetary authorities on financial markets.

So real activity and financial stability impact significantly the dynamics of global liquidity by affecting behaviors of official and private agents. However, the relationships with inflation is less obvious.

A mitigating role of inflation

Unlike to what would have been expected, the inflation before crisis has not contributed significantly to explaining global liquidity dynamics. In fact, according to the inflation targeting, a negative relationship between global liquidity and inflation would have been expected. But as suggested by results, Official as well as private agents (respectively figure 5 and figure 9) do not respond to inflation during the pre-crisis period. As the whole, over this period, it represents only 5% of the variance of global liquidity forecast error. However, with the recent crisis, this impact is much more important (11%). Official and Private agents seem to take into account much more inflation than previously. This can be explained by the dynamics of inflation itself (figure 12). As shown by the graph, inflation stays relatively stable between 1% and 3% which did not justify additional reactions from central banks. The credibility of this inflation targeting policy is also integrated by banks which did not react to any inflation shocks during this pre-crisis period or neglect the eventual negative effects of inflation. Consequently, inflation did not contribute significantly to the dynamics of global liquidity before 2007.

However, over the recent period, higher variability in inflation drives monetary authorities to adjust their policy and the weight of inflation becomes more significant. In addition to this, the adoption of unconventional measures, whose the effects are less well known by central banks, can induce distrusts and fears from private sectors. This permits to justify the bigger role of inflation after the crisis.

Concerning exchange rate, it did not play a significant role in the dynamics of global liquidity no matters the agents and the specifications.

This results are robust to the ordering and remain stable even if only the VIX is considered as measure of financial stability.

6. Conclusion

The dynamics of global liquidity rely essentially on the economic performance, financial stability and to some extent on inflation. Real activity and financial stability, which are the main drivers of liquidity dynamics, hide heterogeneous behaviors between official and private agents. Generally private sector respond by a pro-cyclical manner, which is emphasized with recession and exacerbated with higher

uncertainty. In period of financial stress, banks reduce dramatically the distribution of credit, whereas they were quasi neutral during period of fi- nancial stability. This reaction of private agents is very useful for better understanding the reactions of monetary authorities. As a whole, monetary authorities limit the expansion of private liquidity (funding or market) by restrictive policies in period of economic and financial booms. However, during recession or financial instability, they inject liquidity as a *liquidity supplier of last resort*. This response of central banks quite match their objectives and permit to offset partially, at least, an eventual lack of liquidity. Even when they provide liquidity in period of financial distress, official agents limit their actions in order to avoid moral hazard which could induce from an extensive involvement.

Concerning inflation, its contribution to global liquidity dynamics has to be nuanced before the crisis because of its relatively stable level. However, its higher variability over the recent period can justify a more significant contribution to the dynamics of global liquidity.

Finally, this study has provided a substantial description of the behaviors of each group of agents and contributed to better understanding the dynamics of global liquidity from 1990- to-date. As concluded by Eickmeier et al. (2013), it's therefore very useful to integrate the multifaceted aspect of global liquidity and the interlinkages between its different components in an analysis. Considering only private or official views could biased the perception of the effective liquidity dynamics. As the behaviors of agents are identified, it could be consequently very interesting, as the next step, to focus on researching the efficiency of each group in providing global liquidity and the limitations of their actions in emerging and advanced countries.

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Annexes

Figure 3: Impulse Response function for GLI

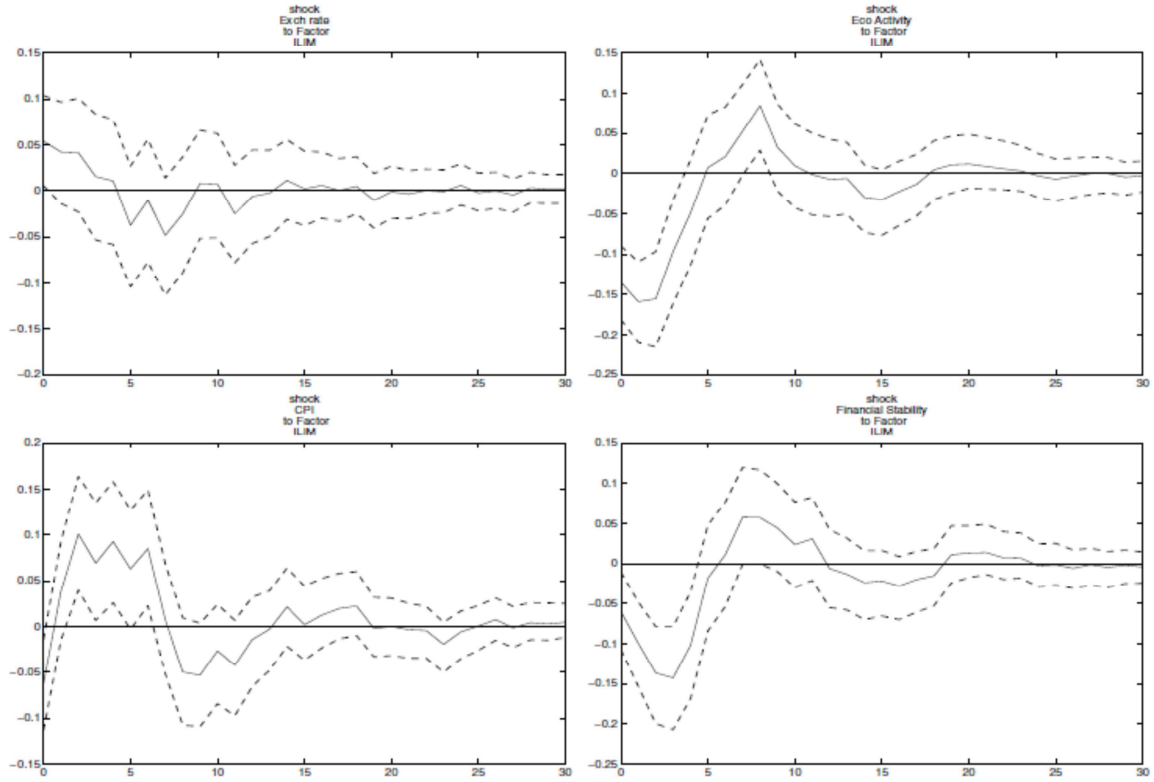


Figure 4: Impulse Response function for GLI before the crisis

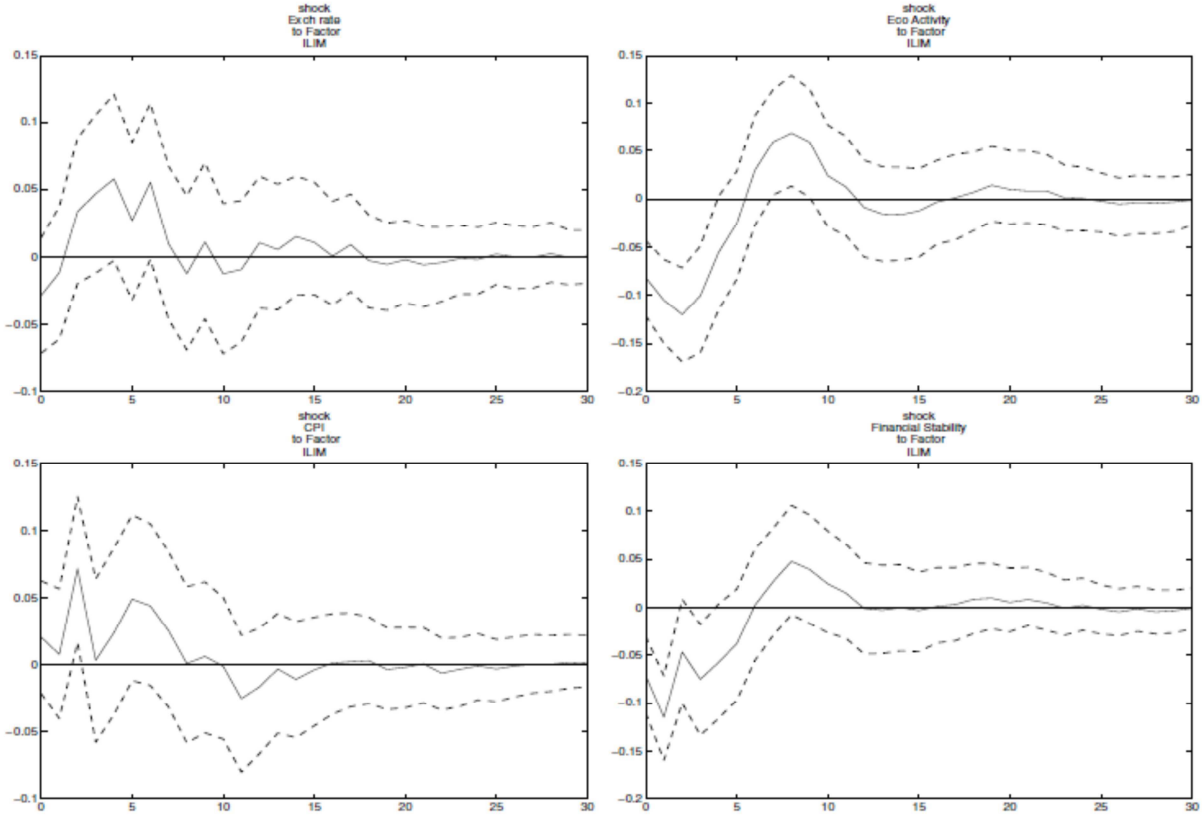


Figure 5: Impulse Response function - Official liquidity

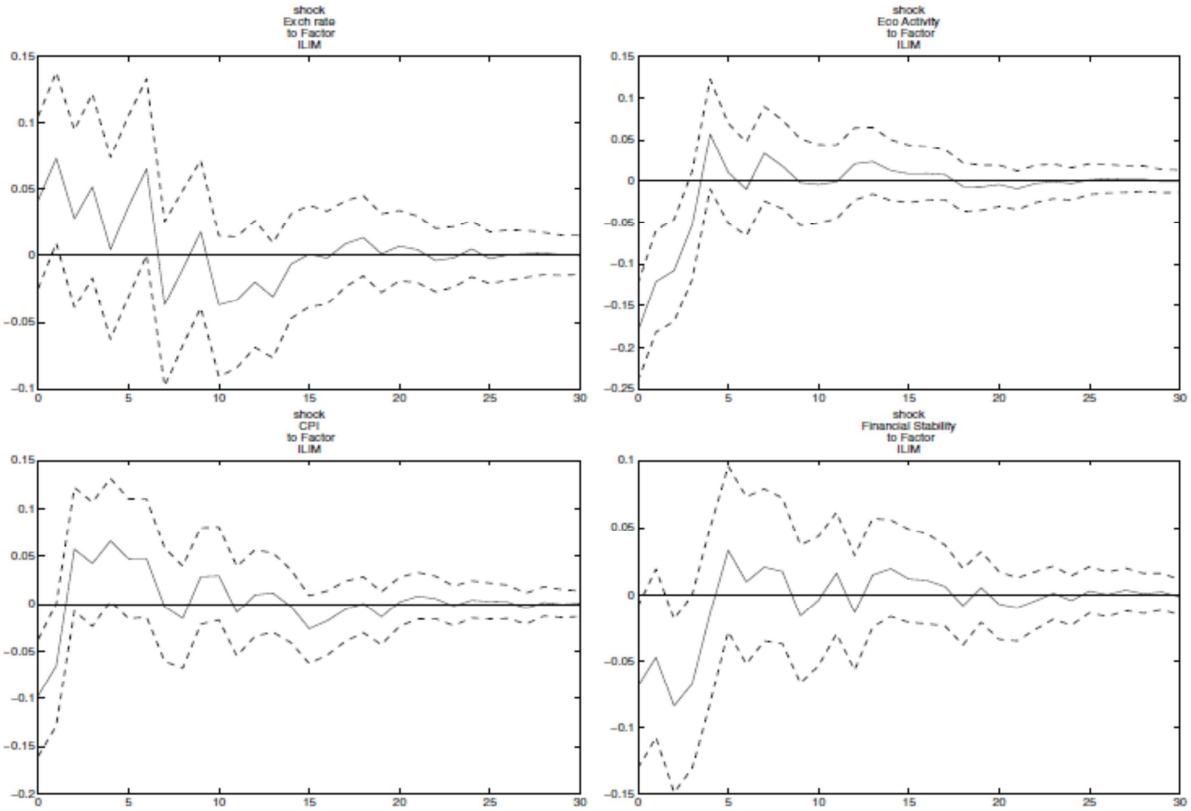


Figure 6: Impulse Response function before the crisis- Official liquidity

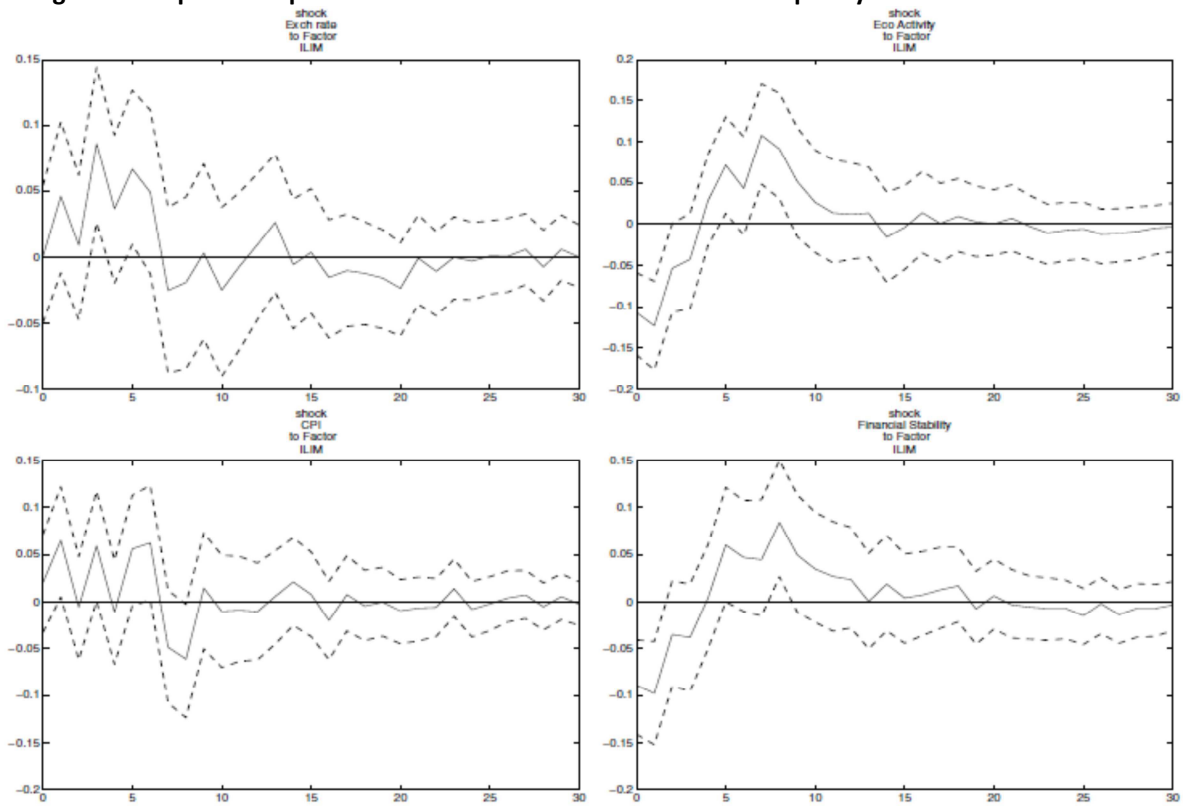


Figure 7: Impulse Response function - Private liquidity

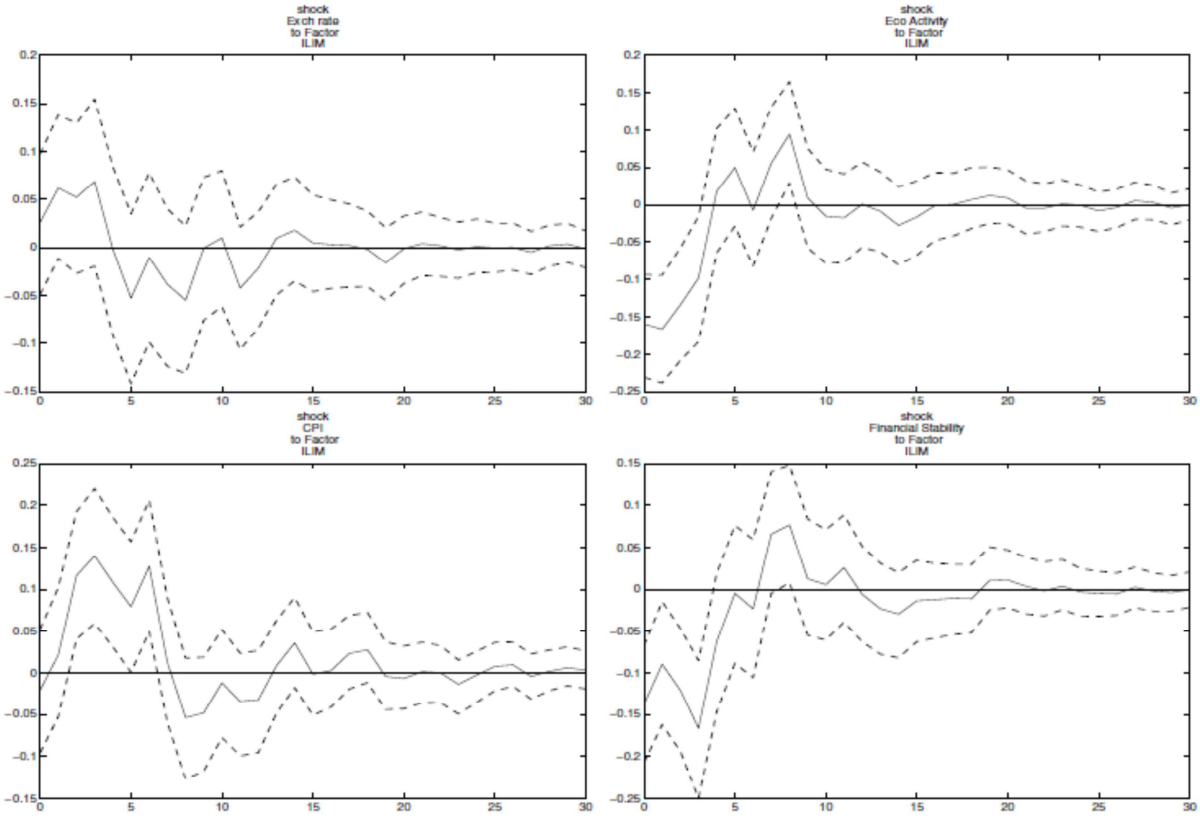


Figure 8: Impulse Response function before the crisis - Private liquidity

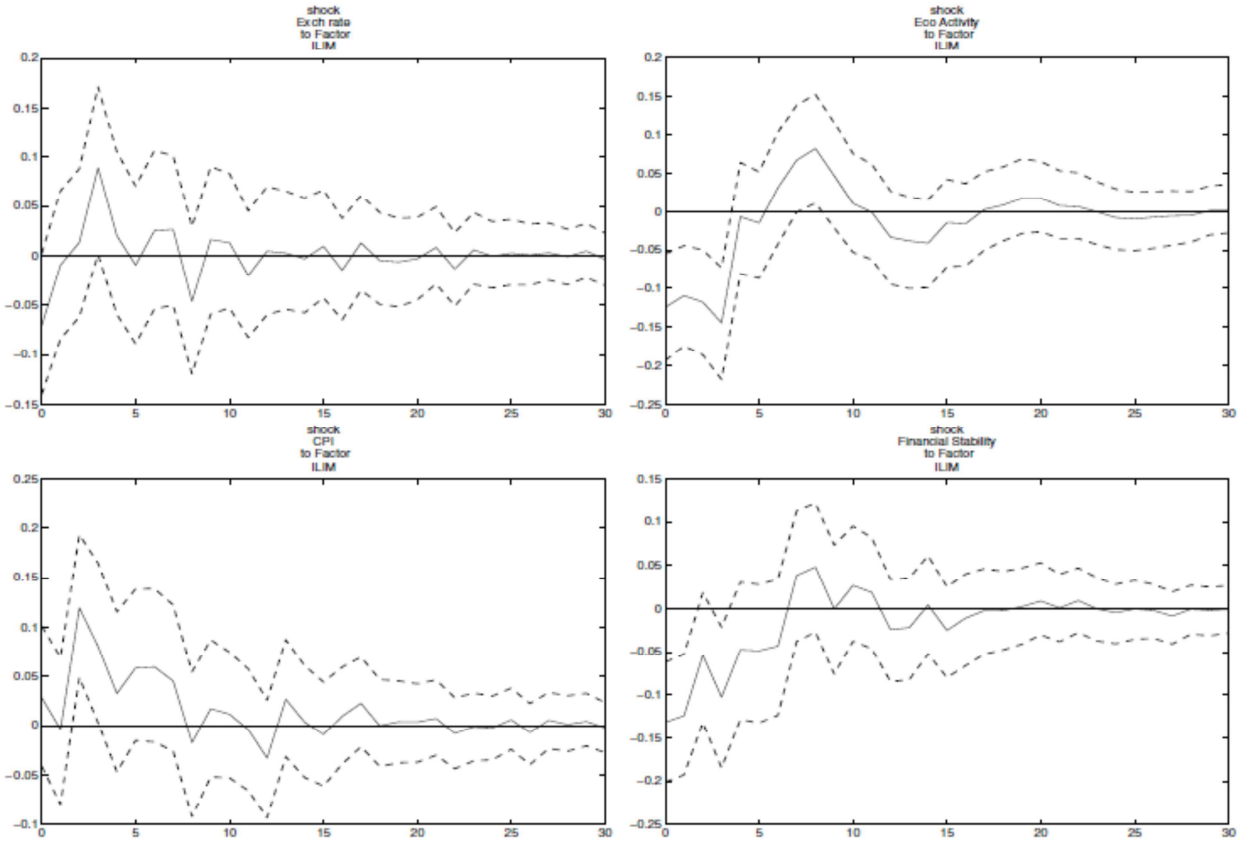


Figure 9: Impulse Response function - Credit

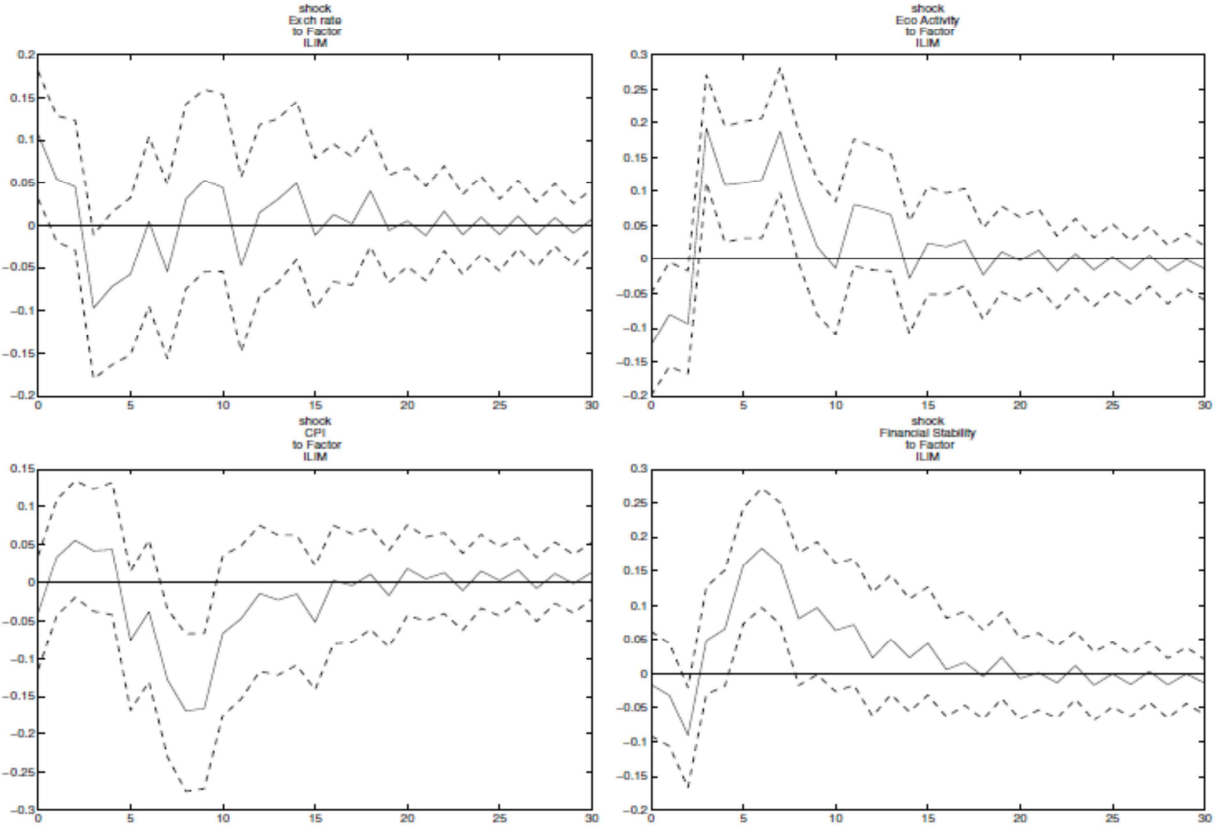


Figure 10: Impulse Response function before the crisis - Credit

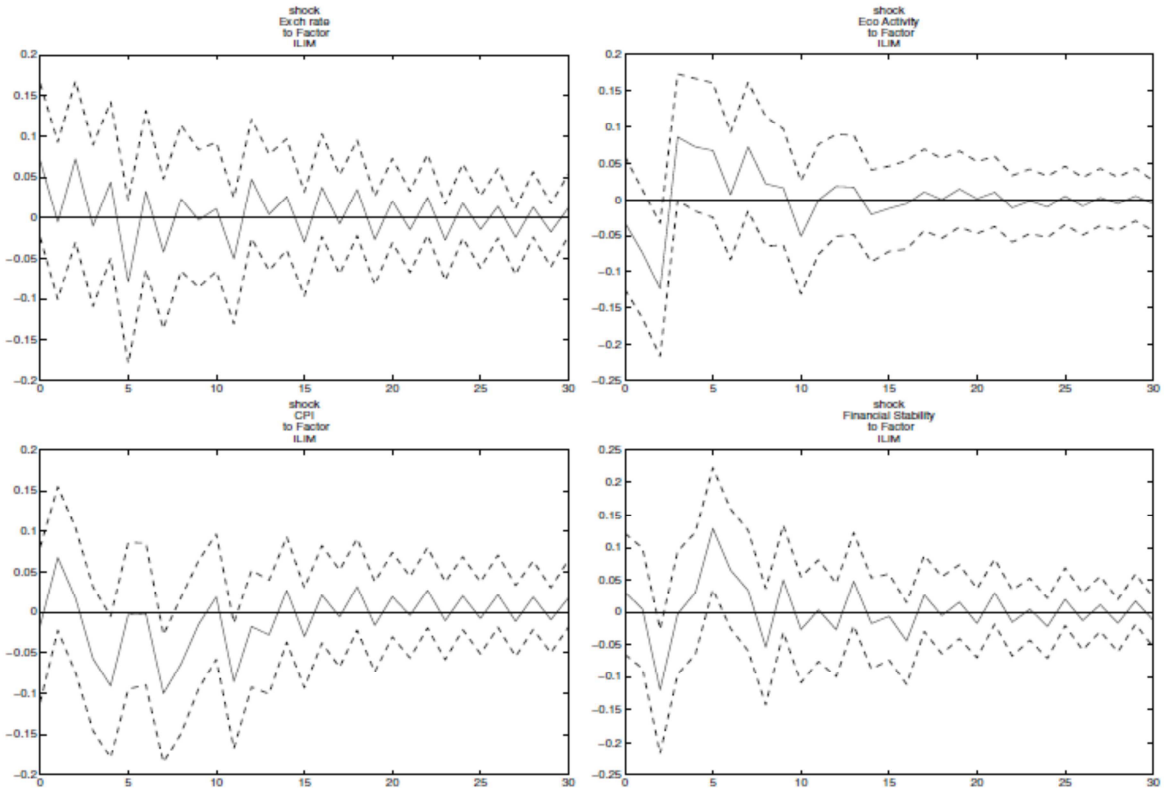


Figure 11: Decomposition of the Forecast Error Variance

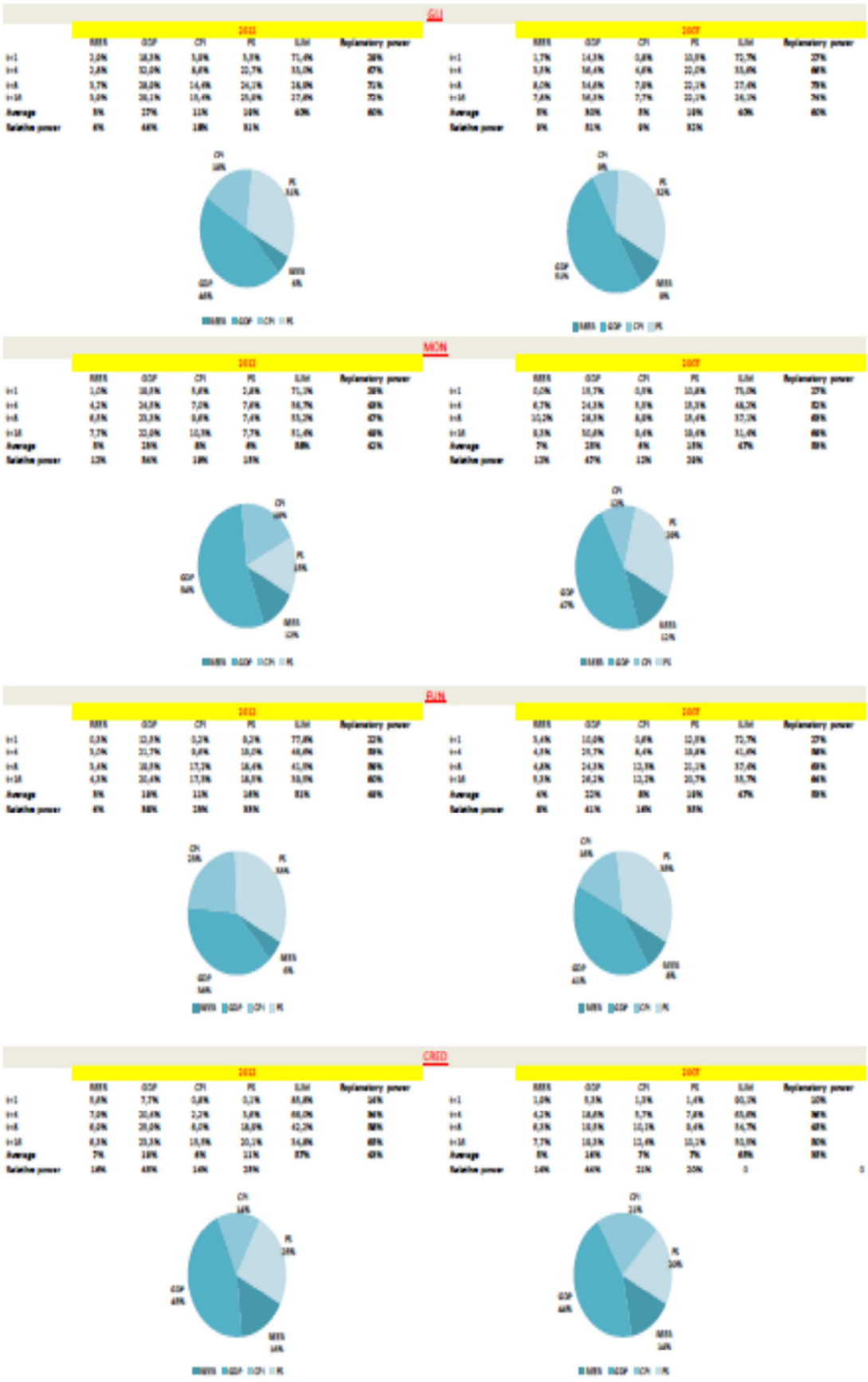
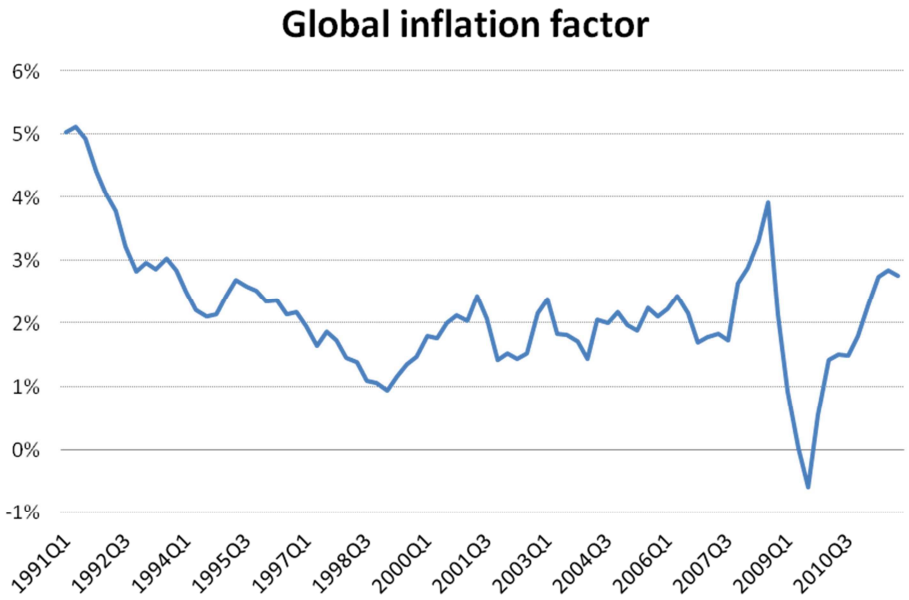


Figure 12: Global annual inflation factor



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