

Does International Liquidity Matter For G-7 Countries? A PVAR Approach

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Received: 06.09.2017 Accepted: 17.12.2017 Published: 16.04.2018
doi:10.33818/ier.336895

ABSTRACT

Global liquidity has been more and more important in the last couple of years and everybody from media to policymakers are talking about it. In order to shed light on the effects of global liquidity, we investigate the impact of global liquidity expansion on major macroeconomic variables of G-7 countries by using panel vector autoregressive (PVAR) model and four different global liquidity indicators. We find that our data is non-stationary, there is cross sectional dependence and no cointegration relationship exists. Impulse response results show that an increase in global liquidity lowers government bond yields and has limited effect on output, inflation and real exchange rate. Additionally, global liquidity explains up to 10 percent of the variation in government bond yields. Our model results imply that the impact of global liquidity on the macroeconomic variables of G-7 countries is not very striking as some other studies suggest.

Key words: *Global Liquidity, Panel Vector Autoregressive, Impulse Response*
JEL Classifications: C33, E44, E51, E52

1. INTRODUCTION

Global liquidity as a concept has been used for a long time but it has become much more popular in the last decade. Expansionary monetary policies, financial innovation and rising leverage in advanced countries led global liquidity to surge in 2000s. Global liquidity glut in this period contributed to increased capital flows to emerging market economies, surging asset prices and higher economic growth. The impact of global liquidity has been so widespread that even the global economic crisis of 2008-09 has been associated with prior ample global liquidity by some scholars (Borio, 2008; Bracke and Fidora, 2012).

Loose monetary policies implemented to support recovery in the post-global economic crisis period again boosted global liquidity. This time, after reaching zero lower bound, major advanced country central banks carried out quantitative easing policies and more than tripled their balance sheets. Booming global liquidity increased risk appetite, capital flows and hence asset prices. There has been a surge in credit and corporate bond issuance in this period. On the other hand, it also caused inflationary pressures and accumulation of risks in emerging market economies. In addition, cheap and abundant external financing opportunities led many emerging market countries to increase leverage in foreign currency and postpone necessary structural reforms.

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Both global liquidity expansion and reduction have striking effects on macroeconomic and financial variables. There are several studies (among them Joyce et al., 2011; Gagnon et al., 2011; Chung et al., 2012; Gambacorta et al., 2014; Neely, 2015; Fratzscher et al., 2017) which show that quantitative easing (QE) programs of advanced country central banks had profound effects on macro and financial indicators of both advanced and emerging market economies. The importance of global liquidity was recognized clearly in May 2013, when the announcement by FED which stated that the asset purchase program might soon be reduced, increased volatility in financial markets and hit the asset prices. Thus, it is of vital importance to study the effects of global liquidity on macroeconomic and financial variables in order to understand contemporary global economy better. In that respect, this study aims to investigate the effects of global liquidity on the major economic variables of G-7 countries.

Although it is a widely used concept, there is still no consensus about the definition and measures of international liquidity. It can be defined as the availability of funds for purchases of goods or assets (Eickmeier et al., 2014) or ease of financing (CGFS, 2011). Global liquidity measures can be divided into two categories as price-based and quantity-based indicators. Price-based indicators include nominal or real interest rates. Sometimes, implied market volatility measures such as VIX can also be used as a proxy for global liquidity. Price-based indicators give information about the conditions under which liquidity is provided (IMF, 2013). As for quantity-based indicators, many empirical studies (Ruffer and Stracca, 2006; Sousa and Zaghini, 2008; D'Agostino and Surico, 2009) have used some global aggregates of broad money as a proxy for global liquidity. More recently, some studies such as CGFS (2011) and Bruno and Shin (2015) have set forth credit as an alternative measure of global liquidity. Especially, the international component of credit (lending across borders to non-residents or lending in foreign currency) is of particular importance (BIS, 2013). While the first phase of the expansion of global liquidity, roughly between 2003 and 2008, had banking in its center, in the second phase which started around 2010 it has been the bond market (Shin, 2013). Due to low interest rates and supportive financial conditions, bond issuance surged in this period and it contributed to global liquidity expansion. Therefore, bond issuance can also be used as a measure for global liquidity. Widespread implementation of quantitative easing programs in the post-crisis period has also been another important source of increasing global liquidity. QE led to surging monetary base in advanced countries and this can be used as another proxy for global liquidity.

There are several reasons that motivate us to conduct a study regarding the effects of global liquidity on leading macroeconomic indicators. First, the concept of global liquidity is in the centre of our lives. The attention of media, academics and policy makers has increased gradually as global liquidity started to affect almost everybody through various channels. Taking into consideration the rising importance of global liquidity, there is a need for comprehensive and illuminating empirical studies in this area. Second, despite its importance and widespread use, the number of empirical studies about the effects of global liquidity on economic variables is still limited. Some of them (Ruffer and Stracca, 2006; Sousa and Zaghini, 2007; Sousa and Zaghini, 2008; D'Agostino and Surico, 2009) focus on the effects of global liquidity on macroeconomic variables such as growth and inflation. Some others (Baks and Kramer, 1999; Belke et al., 2010a; IMF, 2010; Brana et al., 2012; Brana and Prat, 2016) analyse the effects of global liquidity on asset prices and more specifically on commodity prices (Belke et al., 2010b; Beckmann et al., 2014). This study intends to fill the gap and contribute to the existing literature. Third, although there are several different definitions of global liquidity, existing studies usually focus only on one of them. We use four different definitions of global liquidity and this helps us better understand the concept and the effects on macroeconomic indicators. Using four

different indicators can also be regarded as a robustness check. Fourth, providing policy lessons to policymakers is one of the most important motivations for this study. Strong and widespread effects of global liquidity necessitates policymakers to better understand the spillovers it creates. This study tries to shed light on this issue.

The remainder of the paper is organized as follows. Section 2 describes our data set as well as our empirical methodology. Section 3 presents the model results. Section 4 concludes.

2. DATA AND METHODOLOGY

In our study, we use quarterly data from 2000:1 to 2015:2 for G-7 countries (US, Japan, Germany, UK, France, Italy, Canada). Data for Gross Domestic Product (GDP), Consumer Price Index (CPI) and real exchange rate were taken from WorldBank Global Economic Monitor database while the data for government bond interest rates were received from Bloomberg. Data are expressed in logarithmic form and are seasonally adjusted, except interest rates which are used in levels.

The time period we choose is due to data availability. BIS statistics regarding global liquidity starts from 2000. GDP of G-7 economies make up about 50 percent of the global economy and 80 percent of the advanced economies. Taking into account their important role in the world economy, we want to analyze the effects of global liquidity on the economies of G-7 economies.

In this study, we use quantity based indicators to measure global liquidity. One reason we prefer quantity based indicators over price based indicators is that the existing literature such as Ruffer and Stracca (2006), Sousa and Zaghini (2008) and Brana and Prat (2016) all use quantity based indicators. Another reason is that we want to focus on the amount of liquidity instead of the conditions under which liquidity is provided. VIX index is not preferred since it is very volatile. Price based indicators such as nominal and real interest rates are employed in another line of research to analyze the impact of monetary policy and is out of our area of interest.

We use 4 different quantity-based measures. First is the sum of the reference monetary aggregates for G-5 (US, Euro Area, Japan, UK and Canada) weighted by GDP. Monetary aggregates used to calculate global liquidity are M2 for US, M3 for Euro Area, M2 plus certificates of deposits for Japan, M4 for UK and M3 for Canada. Global liquidity aggregate was derived by converting national aggregates into dollar using PPP exchange rates. Following is the formula:

$$GL = \sum_{i=1}^5 M_i^5 E_{PPP}^{i,\$} \left(GDP_i^5 \frac{E_{PPP}^{i,\$}}{GDP_{total}^{\$}} \right) \quad (2.1)$$

where M_i represents each monetary aggregate, $E_{PPP}^{i,\$}$ is PPP exchange rate of the corresponding country, GDP_i^5 is gross domestic product in local currency and $GDP_{total}^{\$}$ is total GDP of countries converted to dollar using PPP exchange rates. This measure of global liquidity was used especially before the crisis of 2008-09 (Among them Ruffer and Stracca, 2006; Sousa and Zaghini, 2007; Sousa and Zaghini, 2008). Second global liquidity measure we use is the international bank claims which includes all BIS reporting banks' cross border credit and local credit in foreign currency. Credit aggregates have some important advantages over other measures. They represent the end of financial intermediation chain and capture the interaction of public and private liquidity (Eickmeier et al., 2014). Credit aggregates have been used extensively as a measure of global liquidity in the post crisis period. However, due to the problems in the banking sector of advanced countries, global credit growth was weak in the

post crisis period. In this period, low interest rates and insufficient amount of credit supply by the banking sector led to a surge in bond issuance. This has contributed to a new phase of global liquidity expansion. Therefore, as a third measure of global liquidity we use total amount of financing which is calculated as the sum of bank loans to non-residents and international debt securities in dollar, euro and yen. These data were gathered from Bank for International Settlements (BIS) statistics. As the fourth measure of global liquidity, we build a proxy for global liquidity as the sum of central bank monetary base of US, Euro Area, Japan and UK. These are the countries that implemented QE policies after the crisis and had the largest contribution to the expansion of global monetary base. This measure of global liquidity takes quantitative easing into account. Since monetary base is expressed in local currency, we convert each into dollar using nominal exchange rates.

Our estimation has four steps: first we test for cross sectional dependence in our data; second, panel unit root test is performed to identify the nature of stationarity of the variables; third, a panel cointegration test is conducted to see whether there is a long-run relationship between the variables; and fourth, a PVAR model is built to analyze the short run effects of global liquidity on other macroeconomic variables.

In the empirical modeling, we first check cross sectional dependency properties of the variables. When we don't take into account cross sectional dependence for panel data models, this may lead to over-rejection of the unit root hypothesis (O'Connell, 1998). Moreover, when cross sectional dependence is ignored, estimators may produce biased and inconsistent results as in the case of omitted variable.

In order to investigate cross sectional dependence, we employ both the Bias adjusted LM test (Pesaran et al., 2008) and CD LM test proposed by Breusch and Pagan (1980). CD test proposed by Pesaran (2004) is also frequently used in the empirical literature when cross sectional dimension (N) is higher than time dimension (T). However, data access improved over time and time series dimension (T) started to dominate the panel literature. If time dimension is greater than cross sectional dimension like our case, CD LM test of Breusch and Pagan and the bias adjusted LM test are preferred.

The LM test statistic given in Breusch and Pagan is as follows:

$$LM = T \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij}^2 \right) \quad (2.2)$$

and the bias- adjusted version of LM test is

$$LM^* = \sqrt{\frac{2T}{N(N-1)}} \left(\sum_{i=1}^{N-1} \sum_{j=i+1}^N \hat{\rho}_{ij} \right) \frac{(T-k)\hat{\rho}_{ij}^2 - E(T-k)\hat{\rho}_{ij}^2}{\text{Var}(T-k)\hat{\rho}_{ij}^2} \quad (2.3)$$

where $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of the error terms taken from OLS. After testing for cross sectional dependence, we investigate stationarity properties of the variables. For stationarity check, we employ 5 different unit root tests. First one is Maddala and Wu (1999) first generation panel unit root test which don't take into account cross sectional dependence.

Maddala and Wu (1999) propose a Fisher-type test:

$$P = -2 \left(\sum_{i=1}^N \ln p_i \right) \rightarrow \chi^2(2n) \quad (2.4)$$

that is based on combining the p -values of the test-statistic for a unit root in each cross-sectional unit.

Second unit root test that we use is CIPS test proposed by Pesaran (2007) which takes into account cross section dependence. Pesaran (2007) augments standard ADF regression with the

cross section averages of lagged levels and first-differences of each series. It is based on the following AR(p) equation below augmented with the current and lagged values of y_t .

$$y_{i,t} = \alpha_i + \gamma_i y_{i,t-1} + \dots \dots \delta_{i0} \bar{y}_t + \delta_{i1} \bar{y}_{t-1} + \dots \dots + \delta_{ip} \bar{y}_{t-p} + \epsilon_{i,t} \quad (2.5)$$

To get the CIPS statistic, this equation is transformed into first difference and individual ADF statistics ($CADF_i$) are computed for every cross section. The simple average of the $CADF_i$ statistics give the CIPS statistics:

$$CIPS = \frac{\sum_{i=1}^N CADF_i}{N} \quad (2.6)$$

Third, we use Breitung and Das (2005) non-factor structure based test as robustness check. The test procedure is based on OLS statistics with panel corrected standard error. This test assumes that the error term is uncorrelated across both i and t . It is robust to cross sectional correlation. And lastly, in order to investigate stationarity of cross-sectionally invariant variable, that is global liquidity, we employ Ng-Perron (2001) test and unit root test with a breakpoint. In Ng-Perron test, the time series is detrended by applying a GLS estimator and it improves the power of the tests when there is a large AR root and reduces size distortions. It is thought to be superior to both Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests. In addition to Ng-Perron test, we also perform unit root test with a breakpoint. Perron (1989) states that unit roots and structural change are closely related and unit root tests are biased toward a false unit root null when the data are trend stationary with a structural break. Therefore, it is of vital importance to consider structural breaks.

After testing for unit root, we investigate co-integration relationship between the variables. We employ second generation Durbin-Hausman (Westerlund, 2008) co-integration test which takes cross-sectional dependence into account. This test can be used even when variables are integrated of different order. The Durbin-Hausman test has 2 dimensions. The Durbin-Hausman panel test (DHp) assumes that the autoregressive parameters are same for all cross-sections, both for the null and alternative hypotheses. The Durbin-Hausman group test (DHg) assumes that the autoregressive parameters differ across cross-sections under the alternative hypothesis. Both for DHp and DHg tests, rejection of the null hypothesis shows the existence of the co-integration relationship. Durbin-Hausman test is calculated as below:

$$\begin{aligned} DH_g &= \sum_{i=1}^n \hat{S}_i (\tilde{\phi}_i - \hat{\phi}_i)^2 \sum_{t=2}^T \hat{e}_{it-1} \\ DH_p &= \hat{S}_n = (\tilde{\phi} - \hat{\phi})^2 \sum_{i=1}^n \sum_{t=2}^T \hat{e}_{it-1} \end{aligned} \quad (2.7)$$

DHg shows group statistics and DHp shows panel statistics.

To analyze the relationship between global liquidity and GDP, CPI, government bond interest rate and real exchange rate for G-7 countries, we employ panel vector autoregression (PVAR) model developed by Abrigo and Love (2015) which is an updated version of Love and Zicchino (2006). It allows for individual heterogeneity in the levels of the variables by including panel specific fixed effects into the model. PVAR model can be written as:

$$X_{i,t} = \Gamma_t X_{i,t-1} + u_i + e_{it}$$

where $X_{i,t}$ is a (5x1) vector of variables GDP, CPI, GL, IR and RER; in which GDP is gross domestic product, CPI is consumer price index, GL is global liquidity indicator, IR is 10 year government bond interest rate and RER is real exchange rate. Γ_t is the lag operator, u_i and e_{it} are vectors of dependent variable-specific panel fixed-effects and idiosyncratic errors, respectively. Optimal lag order is chosen to be 1 by using Akaike, the Bayesian and the Hannan-Quinn information criteria. As fixed effects are correlated with regressors, we use forward mean differencing (the Helmert procedure) following Arellano and Bover (1995) to remove panel-fixed effects. We estimate the coefficients by using generalized method of moment (GMM). As

illustrated in the following section the variables are non-stationary and no cointegration relationship exists between variables and the VAR system in levels is unstable. Therefore, we estimate the model in first differences.

The ordering of the variables is critical in VAR specification. Accordingly, the variables that are more exogenous come earlier in the system and the ones that are endogenous appear later. It means that the variables that come earlier affect the following variables both contemporaneously and with a lag while the variables that come later impact previous variables with a lag. In our specification, GDP and CPI come before global liquidity which is more endogenous compared to GDP and CPI. Growth and inflation developments affect global liquidity contemporaneously, while global liquidity impacts GDP and CPI only with a lag. A change in global liquidity affects government bond yield in the same period but bond yield influence global liquidity with a lag. Therefore, global liquidity is assumed to be more exogenous compared to government bond interest rate¹. Exchange rate reacts immediately to the changes in other variables and thus is the most endogenous variable in our system.

Once the coefficients of the model are estimated, we compute the impulse response functions and the variance decompositions. We use impulse response functions to analyze the impact of global liquidity on major macroeconomic variables of interest. Finally, we also present variance decompositions that show the percentage of the variation in one variable that is explained by the shock to another variable accumulated over time.

3. RESULTS

¹ Central bank policy interest rate is also used instead of government bond yield as a robustness test. In that case, policy interest rate comes before global liquidity since policy interest rate affects global liquidity in the same period, while global liquidity impacts the policy interest rate decision of central banks only with a lag. Therefore, global liquidity is assumed to be more endogenous compared to policy interest rate.

3.1. Cross Sectional Dependence

In order to analyze cross sectional dependence, we employ both Bias Adjusted LM Test and CD LM Test of Breusch and Pagan. Test results are presented in Table 3.1.

CD LM Test (Breusch and Pagan, 1980)	
<i>Variable</i>	Value
<i>GDP</i>	179.036***
<i>CPI</i>	403.170***
<i>GINT</i>	612.312***
<i>RER</i>	308.052***
Bias Adjusted LM Test (Pesaran, 2008)	
<i>Variable</i>	Value
<i>GDP</i>	161.524***
<i>CPI</i>	162.455***
<i>GINT</i>	186.258***
<i>RER</i>	179.543***

Table 3.1 Cross-sectional Dependence Test Results.

Notes: *, **, *** show significance level at 10%, 5% and 1%, respectively. The null hypothesis is no cross-sectional dependence.

According to CD LM test, the null hypothesis of cross-sectional independence is rejected at 1 percent level. Bias Adjusted LM test results also show that there is cross sectional dependence among data. Since $T > N$ in our study, we prefer to use Bias Adjusted LM test.

Cross section dependence has become more and more common because of strong interdependencies between countries due to globalization and common shocks such as economic crises and oil price increases. Variable in country i may be non-spuriously correlated with variable in country j because of common shocks that affect all of the countries at the same time. Therefore, it is intuitive that there is cross sectional dependence among the macroeconomic variables of the G-7 countries.

As there is cross sectional dependence among data, we need to use second generation unit root and co-integration tests that take cross sectional dependence into consideration.

3.1. Unit Root Tests

After we detect the existence of cross sectional dependence, we investigate the stationarity characteristics of the variables by employing second generation CIPS unit root test proposed by Pesaran (2007) and Breitung and Das (2005) test that take into consideration cross sectional dependence. In addition, we also report first generation Maddala and Wu (1999) unit root test in Table 3.2.

CIPS Tests

	Intercept	Intercept + trend		Intercept	Intercept + trend
<i>GDP</i>	1.754	1.515	Δ GDP	-8.643***	-7.891***
<i>CPI</i>	0.744	2.838	Δ CPI	-6.627***	-6.442***
<i>IR</i>	-0.361	0.368	Δ IR	-8.786***	-7.641***
<i>RER</i>	-0.323	-0.289	Δ RER	-9.386***	-8.694***

Breitung and Das Test					
	Intercept	Intercept + trend		Intercept	Intercept + trend
<i>GDP</i>	3.595	-0.020	Δ GDP	-5.934***	-6.280***
<i>CPI</i>	6.601	3.572	Δ CPI	-7.885***	-6.370***
<i>IR</i>	1.204	-0.550	Δ IR	-8.379***	-4.445***
<i>RER</i>	0.282	1.815	Δ RER	-6.964***	-7.132***

Maddala and Wu Test					
	Intercept	Intercept + trend		Intercept	Intercept + trend
<i>GDP</i>	7.866	4.506	Δ GDP	99.802***	74.573***
<i>CPI</i>	9.970	6.335	Δ CPI	126.816***	112.199***
<i>IR</i>	5.264	23.628	Δ IR	25.018***	218.507***
<i>RER</i>	11.680	3.145	Δ RER	160.522***	145.066***

Table 3.2 Panel Unit Root Test Results.

Notes: *, **, *** show significance level at 10%, 5% and 1%, respectively. The null hypothesis for all tests is unit root. CIPS and Breitung and Das tests assume cross-section dependence. MW test assumes cross-section independence.

According to Table 3.2, all three tests we employ show that all of the variables are stationary after differencing, that is they are I(1).

In order to investigate stationarity of the cross-sectionally invariant variable, that is global liquidity, we first employ Ng-Perron test which is one of the most used robust time series unit root test in the empirical literature. Ng-Perron test results are presented in Table 3.3 below.

<i>Series</i>	MZa	MZt	MSB	MPT
<i>GL1</i>	-4.899	-1.448	0.295	17.977
Δ <i>GL1</i>	-22.366**	-3.340**	0.149**	4.098**
<i>GL2</i>	-2.692	-0.943	0.350	27.220
Δ <i>GL2</i>	-28.178*	-3.750*	0.133*	3.254*
<i>GL3</i>	-12.106	-2.443	0.202	7.620
Δ <i>GL3</i>	-28.437*	-3.770*	0.132*	3.208*
<i>GL4</i>	-11.992	-2.444	0.204	7.624
Δ <i>GL4</i>	-24.919*	-3.527*	0.141*	3.672*

Table 3.3 Ng-Perron Unit Root Test Results.

Notes: *, **, *** show significance level at 10%, 5% and 1%, respectively. The null hypothesis is unit root. Δ refers to first difference of the variable. The test constructs four test statistics that are based upon the GLS detrended data.

	Intercept	Intercept + trend		Intercept	Intercept + trend
<i>GL1</i>	-1.952	-4.488	Δ <i>GL1</i>	-5.609***	-5.329**
<i>GL2</i>	-3.477	-1.408	Δ <i>GL2</i>	-8.451***	-8.999***
<i>GL3</i>	-2.152	-4.061	Δ <i>GL3</i>	-7.738***	-8.489***
<i>GL4</i>	-2.961	-3.197	Δ <i>GL4</i>	-6.196***	-6.327***

Table 3.4 Breakpoint Unit Root Test Results.

Notes: *, **, *** show significance level at 10%, 5% and 1%, respectively. The null hypothesis is unit root.

According to Table 3.3, Ng-Peron test shows that all four global liquidity variables are I(1). Table 3.4 also shows that global liquidity indicators are stationary in first differences according to breakpoint unit root test.

3.3. Co-Integration

After we find that all variables are I(1), we investigate co-integration relationship between the variables by employing Durbin-Hausman test which take into consideration cross sectional dependence. The results of the Durbin-Hausman test are given in Table 3.5.

Westerlund (2008) Durbin-h Test	
	Value
<i>DH_g</i>	-1.047
<i>DH_p</i>	-0.953

Table 3.5 Westerlund Durbin-Hausman Test Results.

Notes: The null hypothesis is no cointegration.

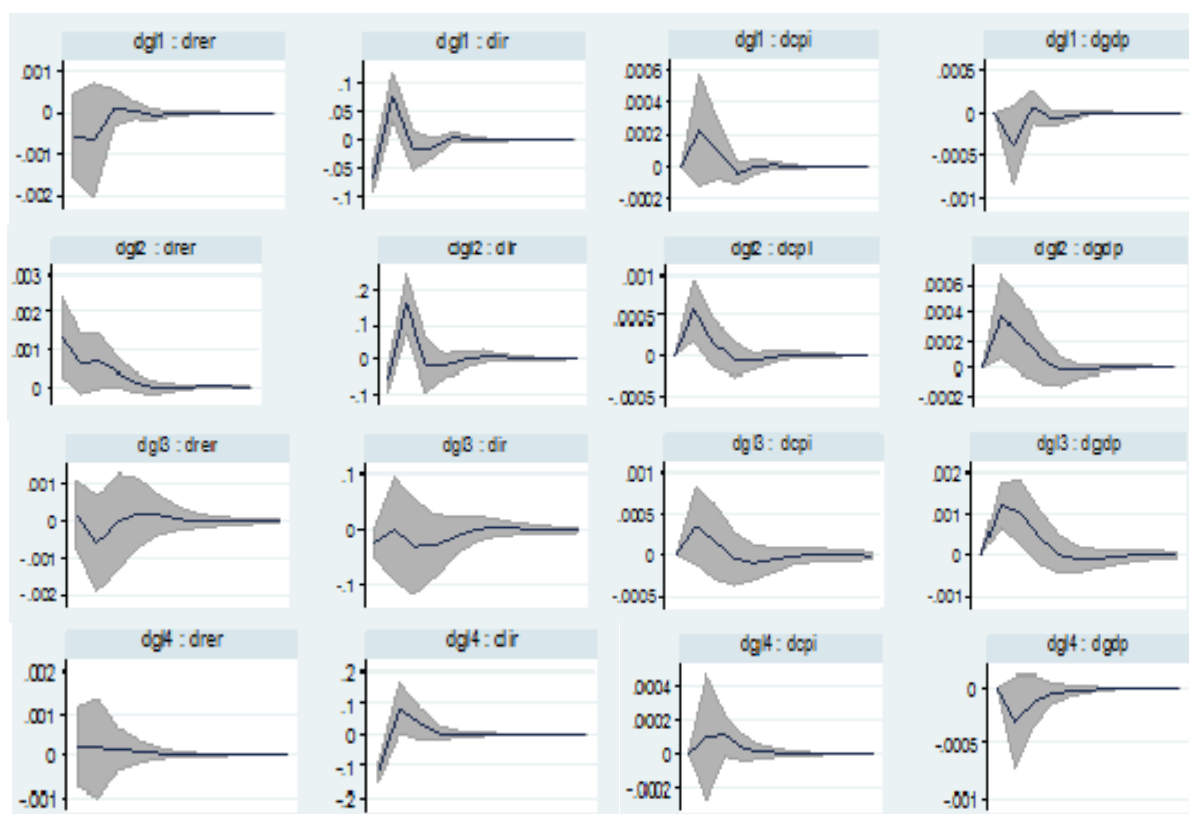
Both the (*DH_g*) and (*DH_p*) tests can not reject the null hypothesis of no-cointegration. Therefore, we conclude that there is no co-integration relationship between the variables.

3.4. PVAR Model

In order to analyze the short run effects of global liquidity on the major macroeconomic variables, we run four models using different measures of global liquidity. The first model employs the monetary aggregate constructed as a measure of global liquidity. The second and third models use international bank claims and the sum of bank loans to non-residents and international debt securities, respectively, as global liquidity measures. Finally, the fourth model uses global liquidity variable based on central bank monetary base.

Figure 3.1 exhibits impulse response functions derived from the estimated panel VAR models. Impulse response from the first model that employs monetary aggregate as a proxy of global liquidity shows that a shock to global liquidity lowers government bond interest rate in the short run but has no significant effect on output, inflation and real exchange rate. Results from the second model imply that global liquidity has a slight positive impact on output and inflation. In addition, global liquidity leads to the appreciation of real exchange rate and has a mixed effect on interest rate in the short term. Third model that uses the sum of bank loans to non-residents and international debt securities as a proxy for global liquidity demonstrates that a shock to global liquidity has a significant positive effect on output while the impact on other variables is insignificant. Finally, according to the results from the fourth model that uses monetary base as a proxy of global liquidity, a surge in global liquidity lowers government bond yields and has no significant impact on output, inflation and real exchange rate.

Figure 3.1 Impulse-responses to a Global Liquidity Shock.



To assess the importance of changes in one variable in explaining changes in other variables, we perform a variance decomposition analysis. Table 3.6 below reports the results of the variance decomposition analysis. These results show that except for the third model, global liquidity explains only a small percentage of the variation in GDP. Similarly, percentage of the variation in inflation and real exchange rate explained by global liquidity is also low. On the other hand, percentage of the variation in government bond yield explained by global liquidity is relatively higher. We see that as much as 10 percent of the variation in interest rates can be explained by global liquidity.

	$\Delta GL1$	$\Delta GL2$	$\Delta GL3$	$\Delta GL4$
ΔGDP	1.2	1.4	17.6	1.0
ΔCPI	1.2	4.1	3.6	0.6
ΔIR	7	6.3	1.8	9.8
ΔRER	0.6	2.2	0.3	0.1

Table 3.6 Variance Decompositions.

Notes: Percentage of variation of the row variable explained by the column variable, in percent, 4 quarters ahead.

Our major findings are robust to the alternative specifications of the panel VAR model. These include the ordering of the variables and the number of lags (2 to 4 lags are estimated). As another test of robustness, we also substitute central bank policy interest rate for government bond yield. Results are similar and can be provided upon request.

4. CONCLUSION

This paper aims to analyze the effects of global liquidity shock on main macroeconomic variables in G-7 countries. To that end, we first investigate the properties of our data and find out that there is a cross sectional dependence among the series. Therefore, we employ second generation unit root and cointegration tests that show the variables are non-stationary and no long run relationship exists among the variables. Then, we analyze the short run effects of global liquidity on main macroeconomic variables of G-7 countries by employing four different panel VAR models that use four different measures of global liquidity. Impulse response analysis results imply that global liquidity expansion lowers government bond yield and has limited impact on output, inflation and real exchange rate in the short run. According to variance decomposition analysis, global liquidity explains the highest percentage of the variation for government bond interest rate among our variables.

Our study contributes to the existing literature from several aspects. Firstly, we enlarge the set of global liquidity measures and this allows us to compare the results of the models using different measures of global liquidity. Secondly, to the best of our knowledge, this is the first empirical study that uses panel VAR model to analyze the macroeconomic effects of global liquidity on G-7 countries. Thirdly, differently from the other studies in the literature, we employ the most recent panel data techniques and tests for cross sectional dependence, unit root and cointegration. Second generation unit root and cointegration tests are used that take cross sectional dependence into account. Fourthly, our study investigates both short and long run impact of global liquidity on major economic variables. Finally, our study also provides valuable policy implications for policymakers. Our findings imply that global liquidity expansion lowers interest rates but has limited effect on output and inflation. Therefore, existing expansionary policies of advanced country central banks to support economic activity and inflation must be taken with caution.

This paper suggests that there is still room and need to study the effects of global liquidity on macroeconomic variables. There are still many questions that can not be answered by the existing literature. In this manner, further studies might aim to analyze the impact of global liquidity on emerging market economies and some other empirical methods might be employed.

REFERENCES

- Abrigo, M.R. and I. Love, (2015). Estimation of panel vector autoregression in Stata: A package of programs. In *Panel Data Conference*. <http://paneldataconference2015.ceu.hu/Program/Michael-Abrigo.pdf>.
- Arellano, M. and O. Bover (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, 68 (1), 29-51.
- Baks, K. and C. Kramer (1999). Global Liquidity and Asset Prices: Measurement, Implications, and Spillovers. *IMF Working Paper*, No. 99/168.
- Beckmann, J., A. Belke and R. Czudaj (2014). Does global liquidity drive commodity prices? *Journal of Banking & Finance*, 48, 224–234.
- Belke, A., I.G. Bordon and T.W. Hendricks (2010a). Global liquidity and commodity prices—a cointegrated VAR approach for OECD countries. *Applied Financial Economics*, 20 (3), 227-242.

- Belke, A., W. Orth and R. Setzer (2010b). Liquidity and the dynamic pattern of asset price adjustment: A global view. *Journal of Banking & Finance*, 34 (8), 1933-1945.
- Bracke, T. and M. Fidora (2012). The macro-financial factors behind the crisis: Global liquidity glut or global savings glut? *The North American Journal of Economics and Finance*, 23 (2), 185–202.
- Brana, S., M. Djigbenou and S. Prat (2012). Global excess liquidity and asset prices in emerging countries: A PVAR approach. *Emerging Markets Review*, 13, 256–267.
- Brana, S. and S. Prat (2016). The effects of global excess liquidity on emerging stock market returns: Evidence from a panel threshold model. *Economic Modelling*, 52, 26-34.
- Breitung, J. and S. Das (2005). Panel unit root tests under cross-sectional dependence. *Statistica Neerlandica*, 59 (4), 414-433.
- BIS (2013). Global Liquidity: Selected Indicators. October, 2013.
- Borio, C. (2008). The Financial turmoil of 2007?: A preliminary assessment and some policy considerations. *BIS Working Paper*, No 251.
- Breusch, T.S. and A.R. Pagan (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies*, 47 (1), 239-253.
- Bruno, V. and H.S. Shin, (2015). Capital flows and the risk-taking channel of monetary policy. *Journal of Monetary Economics*, 71, 119-132.
- CGFS (2011). Global liquidity - concepts, measurement and policy implications. *CGFS Paper*, 45.
- Chung, H., J.P. Laforde, D. Reifschneider and J.C. Williams (2012). Have we underestimated the likelihood and severity of zero lower bound events? *Journal of Money, Credit and Banking*, 44 (1), 47-82.
- D’Agostino, A. and P. Surico (2009). Does global liquidity help to forecast U.S. inflation? *Journal of Money, Credit and Banking*, 41 (2-3): 479-489.
- Eickmeier, S., L. Gambacorta and B. Hofmann, (2014). Understanding global liquidity. *European Economic Review*, 68, 1–18.
- Fratzscher, M., M. Lo Duca and R. Straub (2017). On the International Spillovers of US Quantitative Easing. *The Economic Journal*, doi:10.1111/eoj.12435.
- Gagnon, J., M. Raskin, J. Remache and B. Sack (2011). The financial market effects of the Federal Reserve’s large-scale asset purchases. *International Journal of Central Banking*, 7 (1), 3-43.
- Gambacorta, L., B. Hofmann and G. Peersman (2014). The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis. *Journal of Money, Credit and Banking*, 46 (4), 615-642.

- IMF (2010). Global liquidity expansion: effects on receiving economies and policy response options. *Global Financial Stability Report*, Chapter 4, April.
- IMF (2013). Global Liquidity-Credit and Funding Indicators. *IMF Policy Paper*.
- Joyce, M., Lasasoa, A., Stevens, I. and M. Tong (2011). The Financial Market Impact of Quantitative Easing in the United Kingdom. *International Journal of Central Banking*, 7 (3), 113-161.
- Love, I. and L. Zicchino (2006). Financial development and dynamic investment behavior: Evidence from panel VAR. *The Quarterly Review of Economics and Finance*, 46 (2), 190-210.
- Maddala, G.S. and S. Wu (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61 (1), 631-652.
- Neely, C.J. (2015). Unconventional monetary policy had large international effects. *Journal of Banking & Finance*, 52, 101-111.
- Ng, S. and P. Perron (2001). Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica*, 69, 1529–1554.
- O'Connell, P.G. (1998). The overvaluation of purchasing power parity. *Journal of International Economics*, 44 (1), 1-19.
- Perron, P. (1989). The great crash, the oil price shock, and the unit root hypothesis. *Econometrica: Journal of the Econometric Society*, 1361-1401.
- Pesaran, M.H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22 (2), 265-312.
- Pesaran, M.H., A. Ullah and T. Yamagata (2008). A bias adjusted LM test of error cross section independence. *The Econometrics Journal*, 11 (1), 105-127.
- Ruffer, R. and L. Stracca (2006). What is global excess liquidity, and does it matter? *ECB Working Paper*, 696.
- Sousa, J. and A. Zaghini (2007). Global monetary policy shocks in the G5: A SVAR approach. *Journal of International Financial Markets, Institutions and Money*, 17 (5), 403-419.
- Sousa, J. and A. Zaghini (2008). Monetary policy shocks in the euro area and global liquidity spillovers. *International Journal of Finance and Economics*, 13, 205-218.
- Shin, H.S. (2013). The second phase of global liquidity and its impact on emerging economies. In *Volatile Capital Flows in Korea* (247-257). Palgrave Macmillan, New York.
- Westerlund, J. (2008). Panel cointegration tests of the Fisher effect. *Journal of Applied Econometrics*, 23 (2), 193-233.