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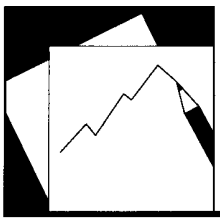

IMF Working Paper

Global Liquidity: Availability of Funds for Safe and Risky Assets

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Research Department

Global Liquidity: Availability of Funds for Safe and Risky Assets[1]

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Abstract

What is global liquidity and how does it affect an economy? The paper addresses that question by looking at liquidity from two different perspectives: global liquidity as availability of funds in safe and risky asset markets. This distinction between safe and risky asset markets is important due to market segmentation, which called for unconventional monetary policy to restore a function of risky asset markets. To analyze the effect of global liquidity, I construct proxy variables and then asses how they affect an emerging economy whose interest rate is affected by a world risk-free rate and a risk premium. Using the data from four major Latin American countries, I find that these two aspects of global liquidity have similar effects on economic performance in emerging market economies except for their effect on inflation.

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I. INTRODUCTION

Global liquidity has been attracting a lot of attention, especially in the media and policy circles as well as in academia. In the past, the discussion on global liquidity was the one of excess liquidity, which was associated with global imbalances, low bond yields, high commodity prices and asset price bubbles. However, beginning in the summer of 2007, the discussion has veered toward liquidity crunches and shortages associated with global financial turmoil. More recently, the discussion is again on the resurgence of global liquidity by the unconventional monetary policies shared by advanced economies.

But what is global liquidity and how does it influence the economy? This paper provides an answer to that question from a perspective of standard new-Keynesian macroeconomic theory with market segmentation. It also presents empirical evidence supporting theoretical predictions based on structural vector autoregressive (SVAR) model applied to four Latin American countries.

Liquidity can be viewed as availability of funds for investment, specifically the availability of funds for investment in safe assets and availability of funds for investment in risky assets. The corresponding prices are the risk-free interest rate and the risk premium. Segmentation of asset markets receives more attention recently since central banks provide "liquidity directly to borrowers and investors in key credit markets" in addition to financial institutions in the traditional money market. These unconventional policies indicate existence of some market segmentation between safe and risky assets, perhaps due to the failure of financial intermediation. The novelty of this paper is its focus on liquidity as availability of funds in these segmented markets as opposed to liquidity shocks as monetary shocks.

I also propose proxy variables to measures these two aspects of liquidity. The availability of funds for safe assets is measured by their quantity; namely, worldwide international reserves plus U.S. monetary base. The second aspect of global liquidity - availability of funds for risky assets - is measured by its corresponding price, the risk premium. I use VIX (Chicago Board Options Exchange Volatility Index) as a proxy for the latter.[2] I use these proxies of global liquidity in SVAR models to analyze how global liquidity shocks affect Latin American countries. As Latin American economies are relatively open and have experienced crises during different periods, the empirical exercise provides a testing ground for usefulness of the proposed measures of global liquidity. An additional advantage of estimating the model for these countries comes from the fact that these are small open economies which are unlikely to affect global liquidity. This simplifies the identification strategy in the SVAR because I can assume econometric exogeneity from theoretical context.

A simple theory suggests that the two concepts of global liquidity should have similar macroeconomic effects in emerging market economies except for their impact on inflation

[2] Another thread of literature is now focusing on the effect of time varying risk or uncertainty. Bloom, Floetotto, and Jaimovich (2009) study the implication of changing uncertainty to business cycle. Their measure of uncertainty is correlated with VIX. Pan and Singleton shows their risk premium is indeed correlated with VIX. In this sense, my paper evaluates an impact of changing uncertainty or risk premium on emerging markets.[2]

and exchange rate.[3] Both lower world risk-free rate and a risk premium typically reduce the cost of funding in an emerging economy and increase growth. Exchange rates normally appreciate unless monetary authorities in emerging economies accommodate their monetary stance to fully match changes in global liquidity. However, there is a difference between the two concepts: while the risk-free rate affects all countries equally, the risk premium affects risky countries (or risky assets) more. As a result, emerging economies benefit more than developed countries from a lower global risk premium as their exchange rates are expected to appreciate due to a lower global risk premium. Since a lower risk premium would not increase world inflation as much as lower world risk-free rate and an emerging market can benefit from exchange rate appreciation, a lower risk premium can reduce inflation in emerging economy. I find that this is largely the case in the data for four major Latin American countries.

This paper belongs to the literature discussing liquidity. However, literature defines liquidity in various ways. Some regard liquidity as the *availability* of funds in the economy, where funds are assets or arrangements that can be easily converted into a medium of exchange. Others regard liquidity as *easiness of convertibility* of assets. For example, checking accounts are more liquid than certificate of deposits. The right measure of liquidity depends on the precise meaning of liquidity and on the question posed. For example, market liquidity of individual stocks in the U.S. is probably less relevant to emerging market economies than funding liquidity of international banks.[4]

Many theories describe the link between liquidity and economic performance including a standard Keynesian theory. There are several papers considering two different kinds of liquidity and its impact on economy. Caballero and Krishnamurthy (2001, 2002) provide a simple model for emerging markets, where they carefully distinguish international and domestic liquidity.[5] This distinction of two concepts of liquidity is motivated by the crises in emerging markets that occur when emerging markets do not have enough *international liquidity*. Neumeyer and Perri (2005) build a small open economy model where real interest rate of the country is decomposed into an international interest rate for risky assets and a country risk. In contrast, my focus is on studying the impact of the world risk-free rate or risk premium on emerging market economy. Several empirical studies have investigated the effect of liquidity or monetary shocks on the economy as well.[6] Some papers investigate the

[3] This paper does not address another interesting issue: how does liquidity in one market affect the other? One reason that I do not answer this question is that VIX and the growth rate of the worldwide international reserves are not highly correlated.

[4] The two aspects of liquidity are interrelated and in some case, it may be necessary to take such interrelations into account. For example, Brunnermeier and Pedersen (2009) study the interaction between market liquidity and funding liquidity. I abstract from such interrelations in this paper for simplicity.

[5] Caballero and Krishnamurthy (2008) consider the US economy as a provider of riskless assets.

[6] For example, Hamilton (1997) estimates the effect of open market operations on federal funds rate.

effect of the U.S. monetary policy shocks on other countries.[7] Canova (2005) investigates the transmission of U.S. shocks to the Latin American countries, which is closely related to the questions addressed in the current paper.[8] However, this paper differs from Canova (2005) in that it investigates global shocks rather than U.S. shocks on Latin American countries. To my knowledge, the effects of global liquidity shocks on emerging economies have not been explored yet despite the recently increased global financial linkages.[9]

Global liquidity has been getting attention in academic literature.[10] Baks and Kramer (1999) measure global liquidity using G-7 money growth and investigate its effect on G-7 asset returns. Sousa and Zaghini (2007) also study the effect of global liquidity, measured as non-Euro area G-7 (i.e. Canada, Japan, UK, and U.S.) monetary aggregate, on Euro Area economy. These papers regard global liquidity as aggregate monetary conditions that are related to the availability of funds for safe assets; that is, only one aspect of global liquidity. Adrian, Etula, and Shin (2008) study the link between exchange rate and global liquidity measured with by the balance sheets of U.S. financial institutions. Specifically, they focus on funding liquidity.

In section II, I provide predictions based on a standard Keynesian view with segmented asset markets describing how two aspects of global liquidity affect emerging market economies and suggest the corresponding measurements. In section III, I describe empirical strategy as well as the data, and in section IV, I discuss the results of empirical study. Section V concludes.

II. A SIMPLE THEORY OF GLOBAL LIQUIDITY AND MEASUREMENT

While a textbook Keynesian model links liquidity to a risk-free rate as it abstracts away from risk, the liquidity preference in a Keynesian theory can be also regarded as behavior towards risk according to Tobin (1958). An asset can get higher return than money because not only it cannot be used for transaction immediately but also it bears higher risk. Following Tobin's view of liquidity, I broaden the concept of global liquidity to encompass availability of funds in both safe and risky asset markets.

This section provides a simple theory and its predictions on how global liquidity could affect a small open economy. Typical DSGE models treat liquidity shock as a single monetary

[7] For example, Kim (2001) and Craine and Vance (2008). Miniane and Rogers (2007) consider the effect of capital controls on the international transmission of U.S. money shocks. di Giovanni and Shambaugh (2008) find that the effects of external interest rate shocks depend crucially on the exchange rate regime.

[8] Other papers investigating the effect of external shocks to Latin American economies include Österholm and Zettelmeyer (2007) and Izquierdo, Romero and Talvi (2008). Their focus is on the effect of economic growth rather than transmission mechanism.

[9] With slightly different perspective, Fostel and Kaminsky (2007) study the effect of global liquidity as a determinant of international capital market access among emerging economies.

[10] See also Jeanne (2009) for theoretical model of global liquidity trap.

shock that affects both safe and risky asset markets; thus, liquidities in both markets are usually perfectly correlated conditioning on the monetary shocks. While they are probably linked in a way that we have not yet understood,[11] I address them separately to allow them to move completely independently. This is extreme but given our lack of understanding of transmission mechanisms from one asset market to the other, it is worth looking at them in various ways. Indeed, the relation between two asset markets are probably time-variant or some unknown function of states given that central banks have to take the unconventional policy to provide liquidity in two different markets. If the central banks knew how availability of funds in safe asset markets (the money market) affects availability of funds in risky asset markets, then they could have applied traditional monetary policy to affect liquidity in both markets.

The availability of funds in the world economy for safe assets should conceptually correspond to the world risk-free interest rate. This should affect all countries in the world equally. This aspect of availability is the first order effect of global liquidity. Second, funding conditions in emerging market economies are also affected by the risk attitude of the rest of the world. This is a reflection of the availability of funds in the world for risky assets. While it is typically regarded as a second order effect and constant, importance of time-varying risk premium has been recognized recently, especially in finance literature. In addition to two main aspects of fund availability, I investigate specific bank funding channels as the funding condition of financial intermediaries in the world could potentially affect emerging countries.

A. Liquidity as Availability of Funds for Safe Assets

I describe how the availability of funds in the world for the investment in safe assets will affect a small open economy by first considering an integrated world economy from Keynesian perspective and then studying its effect on a small open economy. In a sticky price closed economy model such as a typical Keynesian model, liquidity injection, which is usually an increase of money supply, will lower the interest rate.

For example, in a simple but micro-founded New Keynesian model:

$$y_t^* = \mathrm{E}_t\, y_{t+1}^* - \frac{1}{\rho}\left(i_t^* - \mathrm{E}_t\, \Delta p_{t+1}^*\right) \qquad \text{(IS Curve)}$$

$$\varepsilon\left(m_t^* - p_t^*\right) = -\frac{\beta}{1-\beta} i_t^* + \rho y_t^* \qquad \text{(LM Curve)}$$

$$\Delta p_t^* = \beta\, \mathrm{E}_t\, \Delta p_{t+1}^* + \rho\kappa y_t^* \qquad \text{(Phillips Curve)}$$

$$m_t^* = m_{t-1}^* + \eta_t^* \qquad \text{(Monetary Shock)}$$

[11] For example, leverage (see Fostel and Geanakoplos(2008) for the review of literature on leverages) may be one way to link.

a permanent increase in m_t^* induces lower interest rate i_t^*, higher output y_t^*, and higher inflation rate Δp_t^* with reasonable values of parameters (for $\rho, \varepsilon, \beta, \kappa$).

This is a simple model of an integrated global economy. Asterisk indicates the global variables (or the rest of the world). A positive global liquidity shock η_t^* should lower the hypothetical world interest rate and stimulate the world economy. The solution of the above system suggests that i_t^*, y_t^*, and Δp_t^* are proportional to $m_t^* - p_t^*$.[12] Therefore, money balance is a proxy for a world risk-free rate. Of course, the model above is very simple and abstracts away from other important variables; however, this simple model provides a good starting point for studying the effect of global liquidity. Note that the shocks to the system can be easily measured by the changes in nominal money stock in the world, η_t, which justifies my choice of the proxy variable.

The next question is how this global economy affects a small open economy. For a small open economy, output depends at least on either current, past, or expected future level of real exchange rate ($Q \equiv SP^*/P$), world demand (Y^*), domestic inflation (ΔP), and domestic nominal interest rate (i). Domestic inflation depends on the changes in exchange rate, world inflation, and domestic growth. Here I describe these relations in a very general format but one can find them in a standard two country DSGE models or small open economy DSGE models. [13]

$$Y_t = Y\left(\underset{+}{Q}, \underset{+}{Y^*}, \underset{+}{\Delta P}, \underset{-}{i}\right) \tag{1}$$

$$\Delta P_t = P\left(\underset{+}{\Delta S}, \underset{+}{\Delta P^*}, \underset{+}{\Delta Y}\right) \tag{2}$$

In addition, I assume following relationship for exchange rate.

$$\mathrm{E}_t \, \Delta s_{t+1} = i_t - \left(i_t^* + rp_t\right) \tag{3}$$

where rp_t is risk premium. I will discuss risk premium later again as this is the second aspect of global liquidity. Note that equation (3) implies that unanticipated positive shocks to the right hand side variables $\left(i_t - i_t^* - rp_t\right)$ would induce currency appreciation (decrease in s_t).

Some function for i closes the model given rp_t. The effect of a global liquidity shock on an emerging market economy depends crucially on the country's monetary policy as it will

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[12] To see this, denote $\left(y_t^*, \Delta p_t^*, i_t^*\right)^{\mathrm{T}} = \left(\lambda_1, \lambda_2, \lambda_3\right)^{\mathrm{T}} \left(m_t^* - p_t^*\right)$, and $\left(m_t^* - p_t^*\right) = \lambda_4 \left(m_{t-1}^* - p_{t-1}^*\right) + \eta_t$ and then substitute them in the system to verify the system is indeed equilibrium with appropriate values of λ s.

[13] See for example, Devereux and Engel (2003) and Gali and Monacelli (2005).

affect growth and the exchange rate. For example, if monetary policy fully follows the world interest rate, then domestic interest rate can be expressed as $i_t = i_t^*$ and there is no exchange rate appreciation unless risk premium changes. In contrast, a central bank in a small open economy may follow a monetary policy rule of the form $i_t = \bar{i} + \phi y_t + \varphi \Delta p_t$, where y_t denotes output gap, and Δp_t denotes inflation. In an extreme case, the monetary authority of small open economy raises interest rate to fight against the risk of importing inflation. The optimal policy depends on many factors including trade structure, external asset positions, labor market structures, and so on. For example, monetary tightening often induces capital inflow to a small open economy and exchange rate appreciation, which may not be optimal in a sticky price model. I assume that monetary reaction function is a hybrid of two rules: $i_t = i_t^*$ and $i_t = \bar{i} + \phi y_t + \varphi \Delta p_t$, which can be expressed as

$$i_t = \gamma\left(\bar{i} + \phi y_t + \varphi \Delta p_t\right) + \left(1-\gamma\right) i_t^* \tag{4}$$

In some cases, this is equivalent to targeting exchange rate change as well as output gap and inflation as $i_t^* = i_t - rp_t - \mathrm{E}_t\, \Delta s_{t+1}$.[14]

In practice, typical reaction by a monetary authority in a small open economy to a positive global liquidity shock is monetary easing, probably by a smaller degree than a reduction in the hypothetical world interest rate, i.e. $0 < \gamma < 1$. As far as a small open economy reacts to positive global liquidity shocks with lowering interest rates, the prediction of the model is similar to the Keynesian theory of liquidity supply. Note that when a country is trying to peg exchange rate, $\gamma \approx 0$ is a fair assumption, though nominal interest rate of a pegged currency may not be the same as the world interest rate.

In response to global liquidity shocks (lower world risk-free rate), the domestic interest rate of a small open economy will decrease. Accompanied by higher growth in the rest of the world, which is a result of the lower world risk-free rate, the economy of an individual country becomes stimulated and the growth is likely to accelerate as assumed in equation (1). Inflation is likely to increase due to the world inflation and slight domestic monetary loosening although it might to some degree be offset by the exchange rate appreciation as in equation (2). If a small open economy reduces interest rates less than the hypothetical world interest rate, $0 < \gamma < 1$, the exchange rate relative to the world currency should appreciate. Asset prices adjust much faster than goods prices, and returns on equity improve due to the lower discount rate. I will show later that these predictions consistently hold in the data presented.

[14] See Clarida Gali, and Gertler (1998) for empirical evidence of this form.

B. Liquidity as Availability of Funds for Risky Assets

Second, I consider how the availability of funds for risky asset affects emerging economies. In developing a theoretical prediction, I use an observation that emerging economies have to pay a risk premium on their debt. A risk premium rp_t can be defined explicitly as follows:

$$i_t = i_t^* + \mathrm{E}_t \, \Delta s_{t+1} + rp_t$$

This equation replaces UIP or equation (3) and rp_t , which is often called a UIP shock , may reflect a default risk, currency risk, and market liquidity risk among other risks.[15] Particularly, this risk premium is affected by the risk attitude of the rest of the world as well as individual country-specific risk such as default risk. I abstract away from a country specific risk since our focus is global liquidity; therefore, rp_t is an exogenous variable for an emerging economy. While country-specific risks could be also important factors driving the emerging economy (see, for example, Alvarez, Atkeson, and Kehoe (2009) or Tovar (2005)), these are not the main focus of the paper. Therefore, a shock to country specific risks will be subsumed in residuals in county variables.

A lower risk premium can make it easier for emerging countries to obtain funds while developed countries may not benefit from this as much. This difference between countries can change the transmission of global liquidity shocks. A lower risk premium should lower the interest rate and increase the return on assets unless monetary authorities ignore the change in the global liquidity condition. The exchange rate against developed countries can be expected to appreciate strongly if the monetary authority in an emerging country follows the interest rate rule described in equation (4). In this specification, the authority does not fully take advantage of lower risk premium and this implies that risk adjusted return on an emerging country relative to the developed country becomes higher than before. Output growth increases as a result of lower interest rates. However, inflation can decrease if exchange rate appreciates enough since imported goods prices should go down given that lower risk premium should not accelerate world inflation as much as the world risk-free rate. In a simple model described in subsection A, world variables do not change at all although in reality one might expect some growth effects from lower risk premium.[16] The key difference between lower risk premium and lower world interest rate is the effect on exchange rate and inflation rate, although this conclusion hinges on the assumption about a country's monetary policy to a large degree.

[15] See Alvarez, Atkeson, and Kehoe (2007), for interpretation of risk premium defined in this manner.

[16] In a developed country, the private sector or riskier sectors benefit from lower risk premium. This would also enhance the output growth of small open economy through equation (1).

C. Measure of Global Liquidity

This paper uses the changes in worldwide international reserves plus U.S. money supply (M0), both measured in U.S. dollars, as a proxy for a global liquidity, which affects the availability of funds in safe asset markets. This global liquidity measure is widely used among practitioners. In a typical Keynesian model, money supply is considered to be the liquidity. In a global setting, international reserves are a good proxy for that because reserve currencies are used as the medium of international exchange of goods and assets. Additionally, international reserves are typically invested in safe assets such as U.S. treasury bills. One of the advantages of this proxy is the ability to capture the saving behavior in Asia or oil exporting countries, which probably have affected the global liquidity conditions in recent years. Indeed, the growth rate of worldwide international reserves was high in the end of the sample period (2007). Another advantage of this proxy is the availability of data unlike that of the world risk-free rate, which is a hypothetical concept and difficult to measure.[17] Specifically, this paper uses a quarterly growth rate (first log difference) of worldwide international reserves plus U.S. M0.

In order to measure the second aspect of global liquidity as availability of funds for risky assets, I use its price counterpart, the risk premium. VIX is probably the best measure of risk premium at the global level. While VIX is a measure of volatility of S&P index and thus measures 'uncertainty' as well, it is sufficient that VIX is highly correlated with the risk premium.[18] Indeed, VIX is a known proxy for risk premium in the literature.[19] For example, Pan and Singleton (2008) find that the measure of risk premium associated with sovereign bonds is also strongly correlated with VIX. Historically speaking, VIX tends to increase during emerging market crisis periods; VIX has gradually increased recently as the U.S. stock market became more volatile. While VIX is known to be correlated with EMBI index or corporate spread, VIX does not directly depend on countries' or companies' default probability. As paper focuses on global liquidity, which is exogenous to emerging market economies, VIX seems to be a more appropriate measure than EMBI. I use the quarterly average of its logarithm and invert its sign so that the low value of VIX translates into high a value of global liquidity or higher availability of funds for risky assets.[20]

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[17] The result based on U.S. t-bill rate as an alternative measure is available from the author. In sum, it is hard to identify the liquidity shock in a simple structure adopted in this paper with the U.S. t-bill rate. As a result, U.S. t-bill rate works poorly as a global liquidity variable.

[18] "Uncertainty" is also a vaguely defined word. See Bloom (2009), and Bloom, Floetotto, and Jaimovich (2009) for the relation between VIX and uncertainty.

[19] For other examples of risk premium indicators, see Caballero and Panageas (2008).

[20] I also use G7 weighted average of TED spread (between T-bill and Euro Deposit) as a potential measures. Some results are presented in the paper but detailed results are available from the author.

III. EMPIRICAL STRATEGY

To quantify the impact of global liquidity shocks on the small open economy, a structural vector autoregression (SVAR) model is estimated for each country using quarterly data. Each model includes the following six variables: CPI inflation rate, real GDP growth, nominal equity returns, nominal short-term interest rate in domestic currency, the changes of nominal effective exchange rates and a measure of "global liquidity", i.e., worldwide international reserves, or VIX. I discuss briefly the choice of the data below.

Countries included in this study are Argentina, Brazil, Chile and Mexico. The sample period is 1997 Q1-2007 Q4, which includes crises in Argentina and Brazil. Obviously, one might expect the structural change in these countries during the crisis period. This paper, however, does not account for a structural change but rather utilizes these known facts to evaluate the performance of the model and usefulness of the global liquidity measures.

A. An SVAR model

When employing a structural VAR, identification of structural shocks is crucial. In this paper, I rely on an economic theory, which suggests that a small open economy should not influence global liquidity conditions. This implies exogeneity of the global liquidity. Formally, I employ the following model and estimate it using maximum likelihood.

$$\begin{pmatrix} x_t \\ y_t^i \end{pmatrix} = \begin{pmatrix} \varphi(L) & O \\ \phi^i(L) & \Phi^i(L) \end{pmatrix} \begin{pmatrix} x_{t-1} \\ y_{t-1}^i \end{pmatrix} + \begin{pmatrix} \Omega_{1,1} & O \\ \Omega_{1,2}^i & \Omega_{2,2}^i \end{pmatrix} \begin{pmatrix} \eta_t \\ \varepsilon_t^i \end{pmatrix}$$

where y_t^i is a vector of country *i*'s variables, such as output growth rate and inflation rate and x_t is a *scalar* of global liquidity measure. It is easy to see from this representation that global liquidity follows the same process for all countries and the structure of $\Omega_{2,2}^i$, e.g., the ordering of domestic variables, does not affect IRF of y_t^i to the global liquidity shocks. This econometric exogeneity is tested for each country and I find that the econometric exogeneity can be rejected for some specifications.[21] This rejection may look surprising but since each country's economy is synchronized with the global economy, these domestic variables provide some information for predicting global liquidity. Nonetheless, I follow the economic justification and do not allow feedback from Latin American countries' variables to global liquidity.

The restriction imposed by exogeneity is useful in two respects. First, the global liquidity follows the same process in each country as stated. This makes it easier to compare the results from different countries on a common base. Second, it becomes easy to identify global liquidity shocks. Indeed, I do not need any further assumptions in terms of the structure in order to identify the global liquidity shocks while I cannot identify other domestic economy's structural shocks.

[21] Typically, exogeneity can be rejected around 5%-10% for most cases.

In order to identify other structural shocks than global liquidity shocks, I follow standard ordering of the variables: fundamental economic variables, a policy variable, and asset prices. Between two fundamental economic variables, I assume that inflation is the first domestic variable and output growth is the second variable. The third variable is a short-term interest rate in domestic currency, the fourth variable is an exchange rate, and fifth domestic variable is the equity return. In general, reordering among each group (fundamental, policy, and asset prices) of variables does not change the main conclusion.[22] The lag length is assumed to be one because of the short sample periods.

B. Domestic Variables

Latin American countries have experienced hyper-inflation, and some empirical studies exclude inflation rate from the VAR models for that reason. However, inflation in these countries has been more stable in recent years. Moreover, liquidity conditions should affect inflation in the long run. Thus, this paper includes inflation rate as one of the key variables though the sample periods have to be limited. Indeed, the reaction of short-term interest rates to inflation accounts for the key differences among countries. Inflation rate is calculated as quarterly change of log CPI in the baseline model

Output growth is one of the key variables, which is included in most of the studies on Latin America. I use seasonally-adjusted quarterly GDP growth rate calculated as the first difference of the logarithm of real GDP. For robustness check, I use annual growth and the deviation from Hodrick-Prescott (HP) filtered trend as well as industrial production data for some countries.

Short-term interest rate in domestic currency is expected to directly respond to global liquidity shocks and then transmit the shocks to an emerging country. Unfortunately, the data on the short-term interest rates are limited and the exact definition of short-term interest rate depends on the country. I utilize the level of interest rates.

Exchange rate may be another transmission channel through which global liquidity shocks propagate. I use the log difference of quarterly average nominal effective exchange rate in the baseline model. For robustness check, I also use dollar exchange rate (log difference) and real effective exchange rate (log level).

Equity returns are included to analyze if global liquidity indeed affects equity returns as theory predicts. It is also interesting to see how domestic economy reacts to the shocks to equity returns. I use first log difference of the end-of-quarter value of MSCI total return index in local currency as return on equity.

In sum, the order of the variables is the following with appropriate definition of global liquidity.

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[22] By construction, reordering should not affect impulse response of domestic variables to global liquidity shocks at all.

$$\begin{pmatrix} global\ liquidity_t \\ \ln(CPI_t) - \ln(CPI_{t-1}) \\ \ln(GDP_t) - \ln(GDP_{t-1}) \\ short\ term\ rate_t \\ \ln(NEER_t) - \ln(NEER_{t-1}) \\ \ln(Stock_t) - \ln(Stock_{t-1}) \end{pmatrix}$$

IV. RESULTS

A summary of theoretical predictions assuming slight monetary easing by emerging market monetary authorities in response to favorable (positive) global liquidity development is shown in Table 1. The assumption is indeed supported by the data in most of the cases (Table 2), provided that empirical proxies for global liquidity conditions are good indicators.

Figure 1 shows the Z-standardized movements of global liquidity variables as well as the TED spread (T-bill Euro Deposit spread) and U.S. t-bill rate change. Table 3 shows correlation among these measures. Surprisingly, they are almost uncorrelated. Note that the aim is to investigate how different aspects of global liquidity affect performance of emerging market economies rather than how different aspects of global liquidity, i.e., risk-free rate and risk premium, relate to each other. There are some recent attempts to link liquidity conditions and risk premia in theoretical work, e.g., Alvarez, Atkeson, and Kehoe (2009) and Gust and Lopez-Salido (2008). However, it is not yet clear how they are related in the data. Without specifying a monetary policy reaction towards changes in the risk premium, which is probably nonlinear,[23] it is difficult to find an empirical relationship between the risk premium and the risk-free rate. This paper simply treats each of the global liquidity variables separately given the weak correlation among them.

Figure 3-Figure 11 depict impulse response functions to global liquidity shocks, which are the central results of the paper. First, short term interest rates tend to become lower with *positive* global liquidity shocks in most cases.[24] This is consistent with a closed-economy Keynesian model where positive liquidity shocks imply lower interest rates. This finding is robust to alternative measures despite the fact that they are uncorrelated. Second, the global liquidity measure based on either worldwide international reserves or VIX influences Latin American economies (except for Argentina) in line with the simple theory described above. Finally, the magnitude of impulse response is different from country to country and the source of differences seems to be the reaction function of the interest rates. The following sections discuss these findings in more detail.

[23] Bordo and Jeanne (2002) suggest non linear reaction towards asset price bubble.

[24] I use 'positive' for increase of international reserves and lower VIX as these indicate 'positive' or favorable economic conditions. Figure 2 shows the movement of these shocks. Table 4 shows correlations among them.

A. Responses to Global Liquidity Shocks

Figure 3-Figure 6 depict the response of domestic variables to a unit shock to global liquidity, where the measure of global liquidity is a quarterly change of worldwide international reserves plus U.S. M0. As is often the case with the SVAR, the point estimate of the impulse response is not highly significant.[25] However, the qualitative findings based on point estimates are quite robust to the change in specification on domestic variables.[26] In addition, the sign of the responses to liquidity shocks is mostly the same across countries. Moreover, the cumulative impulse responses are often significant as shown in Table 2.

Table 2 indicates that the short-term interest rate in every country falls in the long run, showing that basic assumption of reducing the interest rate in response to a positive global liquidity shock is valid. Except for Argentina, short-term interest rates fall on impact in response to a positive global liquidity shock (green break lines in Figure 3-Figure 6). Note that a similar reaction of short-term interest rates can be also found in Figure 7-Figure 10 where the measure of global liquidity is log of VIX. These results indicate that the assumption on monetary authorities' easing in response to a positive global liquidity shock is verified in emerging market economies. It also reflects that worldwide international reserve and VIX are good measures of global liquidity.

Responses of exchange rates are also in line with theory predictions. Whether global liquidity is measured with worldwide international reserves or VIX, the exchange rate appreciates. This suggests that an emerging economy does not reduce interest rates fully to offset the changes in the world risk-free rate or the risk premium. Note that except for Argentina, exchange rate response to VIX shocks relative to the interest rate response is typically larger than its response to worldwide international reserves shocks relative to the interest rate response as in Table 2. Alternatively, it can be seen by comparing interest rate and exchange rate movements in Figure 3-Figure 6 and those in Figure 7-Figure 10. This also suggests that the risk premium channel transmits global liquidity to emerging markets through exchange rates rather than interest rates.

Inflation increases slightly (Mexico being the exception) when global liquidity is measured with the change in worldwide international reserves. Higher inflation in emerging countries is probably due to the world price increase in response to a positive global liquidity shock and higher domestic growth. In contrast, a VIX-measured of a global liquidity shock reduces inflation except in Argentina. This reflects the fact that the global liquidity shock measured by VIX also induces appreciation of the exchange rate, again with the exception of Argentina. Therefore, these empirical findings are in line with the theory prediction that the

[25] Confidence intervals drawn in the figures are 60% and 80% bootstrapped intervals.

[26] Figures that contain different variables as well as matlab programs are available from the author. Figures in this paper are best viewed in color. Note that the change in orders of domestic variables should not affect the impulse response from global liquidity shocks at all thanks to the exogenous assumption.

availability of funds for safe assets and the availability of funds for risky assets have different effects on inflation compared to the exchange rates.

Table 2 shows that output growth also increases in response to a positive global liquidity shock measured with the change in the worldwide international reserves and VIX. This empirical finding of higher growth is probably caused by the lower domestic interest rates rather than worldwide growth. This can be seen in Figure 3-Figure 6, where domestic output growth reacts stronger after interest rates decrease significantly. Since world growth in theory follows global liquidity, the small reaction of domestic economic growth on impact indicates that the world growth does not have strong effects although the actual world output growth may be delayed in response to a positive global liquidity shock. Similar response is also present albeit weaker in the case of VIX as a measure of global liquidity as in Figure 7-Figure 10. Note that Argentina, where short term interest rates become volatile in response to a global liquidity shock, which is measured by either the change in the worldwide international reserves or VIX, still enjoys economic growth in these two cases.

Finally, equity returns increase on impact including in Argentina. Since asset prices are more flexible than goods prices as modeled in Dornbusch (1976), they should respond positively to positive global liquidity shocks. These findings also support changes in the worldwide international reserves or VIX as an appropriate global liquidity measure. In the case of G7-TED, the equity return does not show a definitive pattern.

Overall, the reaction of the Latin American economies (except Argentina) to global liquidity shocks measured by either worldwide international reserves plus U.S. M0 or VIX is consistent with the theory predictions. The positive shock reduces domestic interest rate, increases output growth, appreciates the currency, and improves equity return. Moreover, the effects of global liquidity on inflation measured with international reserves and VIX shed light on two different concepts of global liquidity. Although they have similar effects on many variables, a positive shock to the availability of funds for risky assets, which corresponds to a lower risk premium, tends to decreases inflation while a positive shock to the availability of funds for safe assets, which corresponds to the lower risk-free rate, tends to increase inflation. The availability of funds for safe assets and that for risky assets clearly have different transmission mechanisms. It is reassuring that a simple measure such as worldwide international reserves or VIX affect an emerging economy as predicted by the theory.

As a robustness check, I also use the change of G7-weighted-TED spread as a global liquidity measure. Figure 11 shows the impulse responses to G7-TED shocks. The results are in general weak and mixed. A global liquidity shock measured by G7-TED change tends to marginally decrease output growth. This is puzzling because interest rate reduction in response to a TED shock does not stimulate growth in the cases of Brazil and Mexico. This casts doubt on the usefulness of a TED spread as a proxy for global liquidity. This may be because G7-TED is not as broad and bank finance may not be as important as the funding source that two other measures of global liquidity are capturing. While TED seems to be an inferior measure of global liquidity, this may be due to the nonlinear nature of financial intermediary channels as described in Caballero and Krishnamurthy (2005).

I also use the U.S. t-bill rate in the same way as other global liquidity measures. That is, the residual of the auto regressive process is regarded as a shock. The purpose of this additional exercise is to evaluate how useful global liquidity measures are compared to the simple U.S. t-bill rate. The t-bill measure does not generate reasonable impulse response within this simple framework. Because U.S. t-bill rate is a function of the U.S. economy, it is hard to identify true monetary 'shock' without controlling it. Moreover, Barakchian and Crowe (2008) find that traditional ways of identifying monetary policy shocks generate different impulse functions using recent sample periods compared to earlier periods. They suggest an alternative way of identifying U.S. shocks but it is difficult to identify a global liquidity shock using interest rate as policy functions may change over time.

B. What Causes Different Response Among Countries?

While qualitative responses are similar among Brazil, Chile and Mexico, quantitatively they are different. Moreover, Argentina behaves qualitatively differently. What can potentially generate different impulse responses among countries? As discussed in the theory section, responses depend strongly on the countries' monetary policy reaction functions.

Argentina behaves differently in particular because its monetary policy in some part of the sample period followed exchange rate stabilization, or $\gamma \approx 0$ in equation (4). This known fact can be confirmed by the empirical results that interest rates follow exchange rate in Figure 3, Figure 7 and Figure 11. Figure 12 shows the impulse response of domestic variables to exchange rate shocks where global liquidity is measured with worldwide international reserves. Except for equity returns, domestic variables of other countries do not respond as much as those of Argentina. The short-term interest rate in Argentina increases in response to the depreciation and then follows the exchange rate. These differences are not surprising given Argentina's history during the sample period. Note that any other shocks that can affect exchange rate might also induce interest rate responses but the magnitude of the interest rate response to exchange rate movement indicates its exchange rate stabilization efforts.

The impulse responses to global liquidity shocks in other countries are similar qualitatively but they tend to be smaller in Chile. This may be because of the smaller size of capital markets in Chile, especially smaller presence of foreign investors. However, Chile also stabilizes more quickly. This may be because its economic policies prioritize the stability of economy. That is $\gamma \approx 1$ in equation (4) or large values of ϕ and φ (the reaction of interest rate to inflation and the output gap). This can be seen as the response to inflation shocks.[27] The nominal short term interest rates react on impact by more than the size of the inflation shock, indicating that monetary policy responds with real tightening. Argentina and Brazil during the sample period behave differently. The reaction of Mexico is similar to Chile but hump-shape reaction of interest rate indicates a slightly delayed response. It takes somewhat longer to stabilize inflation. In the sample, Chile followed inflation targeting long enough to generate impulse responses, which indeed look like responses of a central bank following

[27] Note that Chile also has fiscal rules that stabilize its economy.

inflation targeting. Mexico also appears to be similar to a certain degree. While this may not be the definitive evidence, inflation targeting policy seems to make a country more resilient to global liquidity shocks.

V. CONCLUSION

This paper studies the impact of global liquidity on emerging market economies with the application to Latin American countries. The global liquidity proxies proposed in this paper capture liquidity conditions in safe and risky asset markets. Positive global liquidity shocks in emerging market economies tend to generate lower interest rates, more appreciated exchange rates, higher output and higher equity returns.

The different impulses to liquidity shocks on inflation based on different measures of global liquidity are also consistent with the theory predictions as two different aspects of global liquidity, the world risk-free rate and a risk premium at the global level, have different transmission mechanisms. The world risk-free rate corresponds to a concept of global liquidity as the availability of funds for safe assets. It is measured by worldwide international reserves. VIX index measures global liquidity from a different angle, which corresponds to the availability of funds for risky assets. Risk premium affects emerging economies more than developed countries. I find that these measures behave as predicted by the theory. These empirical findings support basic theoretical transmission mechanisms and confirm the usefulness of these variables as global liquidity measures. While the study is focused on emerging markets, the distinction of availability of funds for safe and risky assets is important, as emphasized in Caballero and Krishnamurthy (2008). The recent financial crisis shows that the availability of funds for risky asset has dried up while risk-free rate has declined substantially. In response to that situation, monetary authorities provide liquidity to both traditional money market and key credit markets. I demonstrate how this global situation can affect emerging economies.

Country differences seem to stem from the differences in monetary policy. Inflation targeting mitigates external shocks. Although almost by definition inflation stabilizes with this policy, output growth and exchange rates also stabilize quickly. This supports common wisdom that inflation targeting is a useful monetary policy goal for emerging countries.[28] However, these findings of this paper are based on the country comparison and may be affected by other factors. Thus, further study is needed to conclude that inflation targeting is an optimal monetary policy.

Finally, while this paper shed some light on the transmission mechanism from two kinds of global liquidity shocks-shocks to the fund availability in safe and risky asset markets to a small open economy, the interaction between these two markets requires further investigation.

[28] Mishkin (2000) discusses advantages and disadvantages of inflation targeting in emerging markets. Ball (2010) claims there is little effect from adopting inflation targeting except for emerging countries.

Table 1: Predicted Responses to Positive Global Liquidity Shocks

	World Interest Rate	Risk Premium	Financial Intermediary
Inflation	+	-	*
Output	+	+	+
Interest Rate	-	-	-
Exchange Rate	- (appreciation)	- (appreciation)	*
Equity Return	+	+	+

* indicates ambiguous response

Table 2: Actual Response to Specific Global Liquidity Shocks

	ARG	BRA	CHL	MEX
Δ World International Reserve (σ=0.016)				
Inflation	0.12	0.22	0.28	*-0.97*
	(-0.94 0.99)	(-0.33 0.78)	(-0.08 1.14)	(-1.81 -0.33)
Output	1.41	0.63	0.43	0.07
	(0.65 2.72)	(0.35 1.07)	(-0.02 1.09)	(-0.30 0.58)
Interest Rate	-4.34	-3.83	-4.05	-6.06
	(-12.62 0.87)	(-7.68 -0.84)	(-7.83 -0.77)	(-11.01 -2.30)
Exchange Rate	-0.38	-2.36	-0.55	-0.09
	(-5.42 3.53)	(-5.33 -0.18)	(-2.51 1.27)	(-0.98 0.64)
Equity Return	3.61	2.72	1.14	2.70
	(-0.06 7.23)	(-0.04 5.91)	(-3.40 5.00)	(0.27 6.15)
(-log) VIX (σ=0.18)				
Inflation	*0.09*	-0.07	-0.01	-0.06
	(-0.03 0.28)	(-0.18 0.01)	(-0.08 0.04)	(-0.20 0.05)
Output	0.19	0.07	0.04	0.04
	(0.08 0.42)	(0.03 0.17)	(-0.02 0.12)	(-0.00 0.13)
Interest Rate	-0.59	-0.72	-0.08	-0.39
	(-1.53 0.12)	(-1.51 -0.33)	(-0.52 0.58)	(-1.20 0.33)
Exchange Rate	*0.00*	-0.63	-0.17	-0.14
	(-0.57 0.61)	(-1.29 -0.32)	(-0.47 -0.01)	(-0.32 -0.04)
Equity Return	0.79	0.44	0.42	0.75
	(0.34 1.70)	(0.10 1.16)	(-0.03 1.09)	(0.38 1.62)
(-Δ) G7-TED (σ=0.11)				
Inflation	0.08	0.01	-0.05	-0.08
	(0.00 0.18)	(-0.06 0.07)	(-0.09 -0.02)	(-0.25 0.02)
Output	*-0.11*	*-0.02*	*-0.02*	*-0.03*
	(-0.21 -0.01)	(-0.07 0.03)	(-0.07 0.02)	(-0.08 0.02)
Interest Rate	*0.68*	-0.00	*0.02*	-0.49
	(0.12 1.40)	(-0.57 0.41)	(-0.46 0.49)	(-1.58 0.11)
Exchange Rate	0.45	0.19	-0.02	0.04
	(0.08 0.89)	(-0.12 0.46)	(-0.22 0.14)	(-0.09 0.14)
Equity Return	0.22	*-0.28*	0.21	0.09
	(-0.22 0.64)	(-0.62 0.08)	(-0.24 0.76)	(-0.19 0.58)

21 period cumulative impulse response from a unit shock with 80% bootstrap confidence interval in parenthesis.

Italic indicates a wrong prediction.

σ indicates the standard deviation of shocks.

Note that initial responses can be different sign.

Table 3: Correlation among Global Liquidity Measures

	International reserves	TED	VIX	T-Bill
International reserves	1.00	-0.23	0.35	-0.02
TED	-0.23	1.00	-0.03	-0.16
VIX	0.35	-0.03	1.00	-0.48
T-Bill	-0.02	-0.16	-0.48	1.00

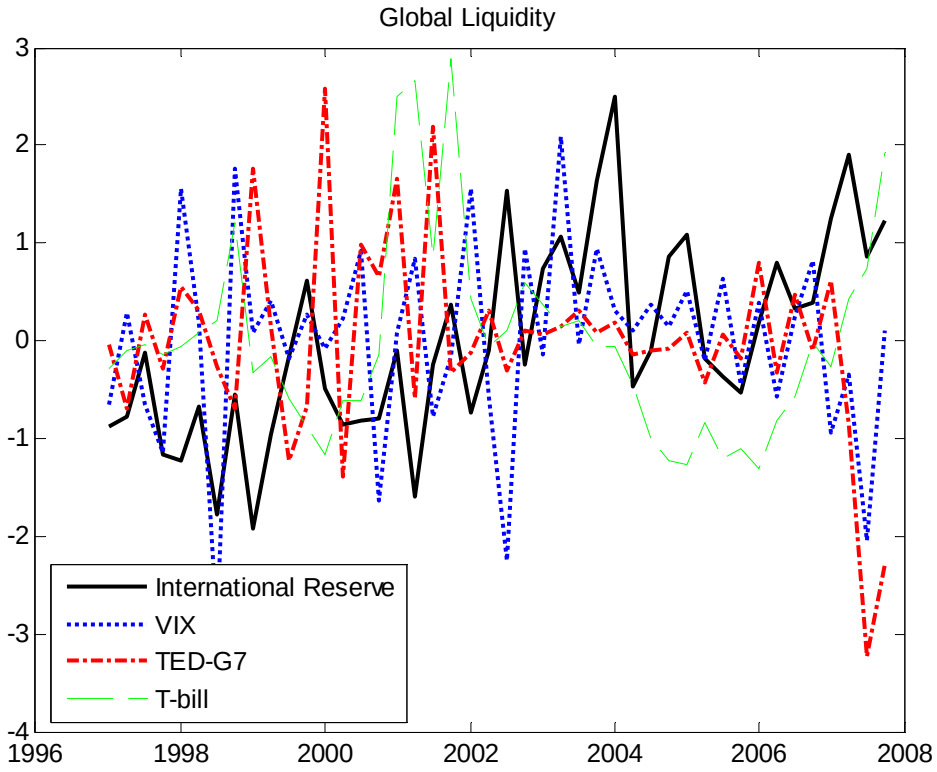
Note that except for VIX, they are quarterly changes

Table 4: Correlation among Global Liquidity Shocks

	International reserves	TED	VIX	T-Bill
International reserves	1.00	-0.10	0.05	0.14
TED	-0.10	1.00	0.10	-0.26
VIX	0.05	0.10	1.00	-0.13
T-Bill	0.14	-0.26	-0.13	1.00

Note that shocks are defined as residuals from univariate autoregression.

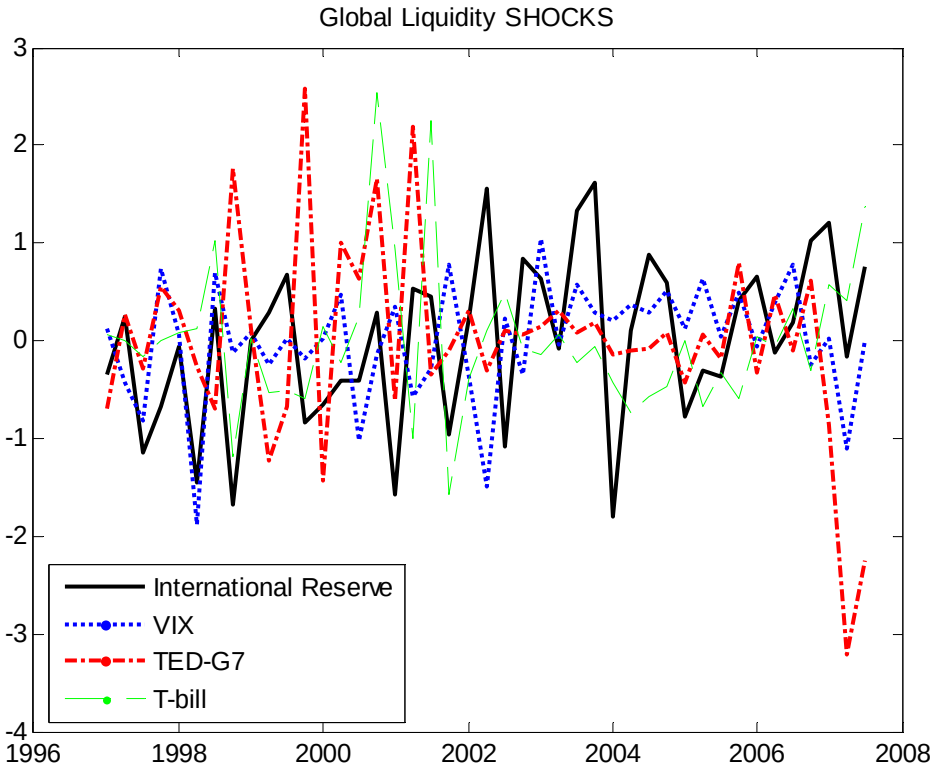
Figure 1: Standardized Measure of Global Liquidity and Related Liquidity



NOTE:

- All values are Z-standardized.
- International Reserve: the first difference of sum of worldwide international reserves and the US M0 in US dollar.
- VIX: logarithm of *inverse* of quarterly average of VIX. (A higher value indicates lower VIX)
- TED-G7: *negative* of changes of quarterly average G7 weighted TED spread. (A higher value indicates shrinking TED spread.)
- T-Bill rate: *negative* of changes of quarterly average T-bill rate.

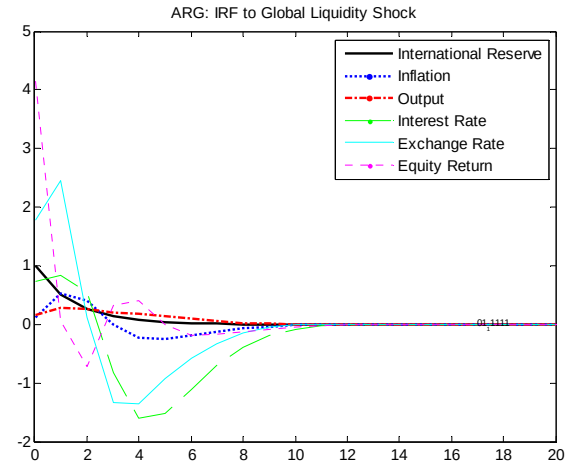
Figure 2: Unanticipated Shocks of Liquidity Measure

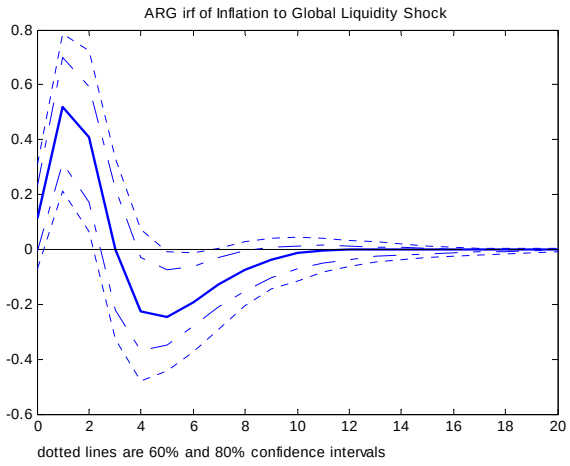


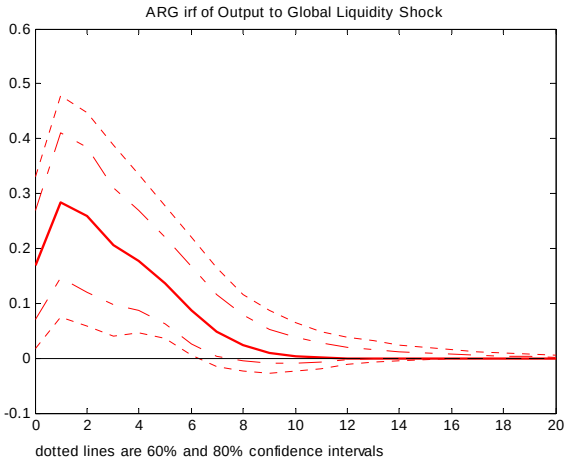
Note:

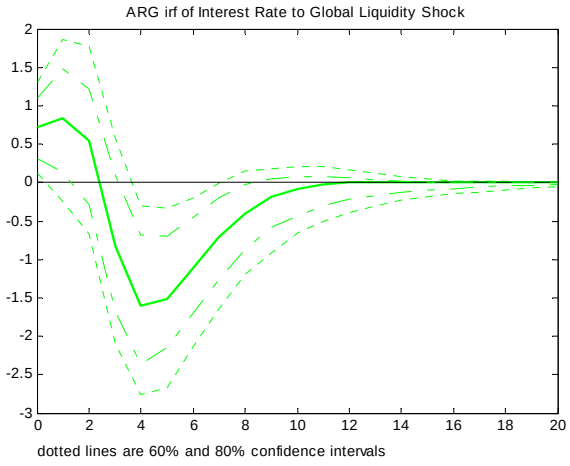
- Shocks are defined as the residual of first-order autoregressive (AR1) processes.

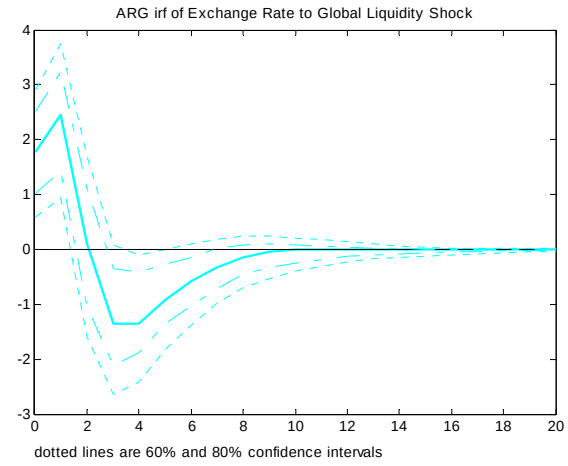
Figure 3 : Argentina: Impulse Responses to Global Liquidity Shock (World Reserve)











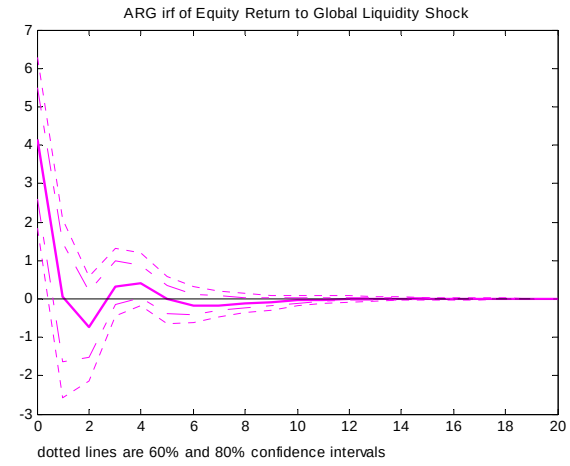
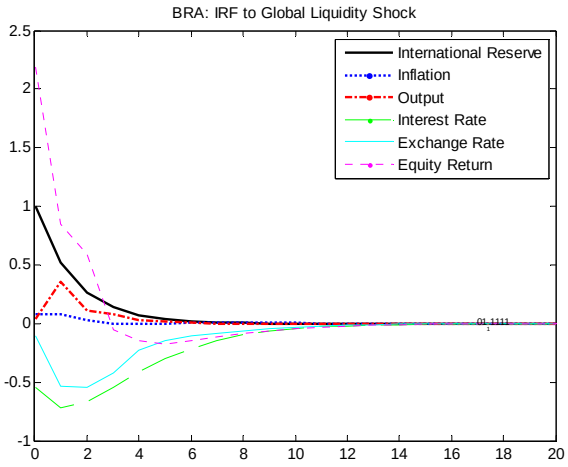
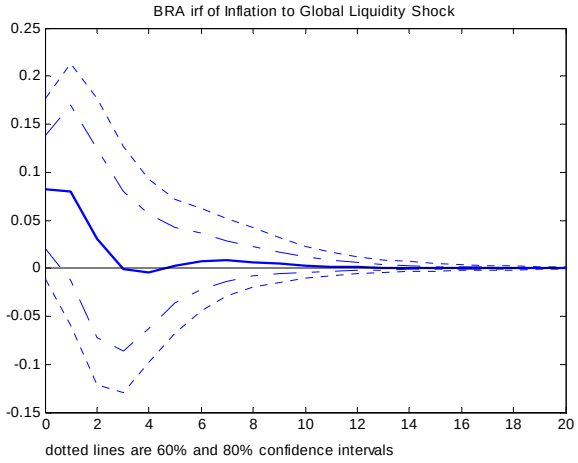
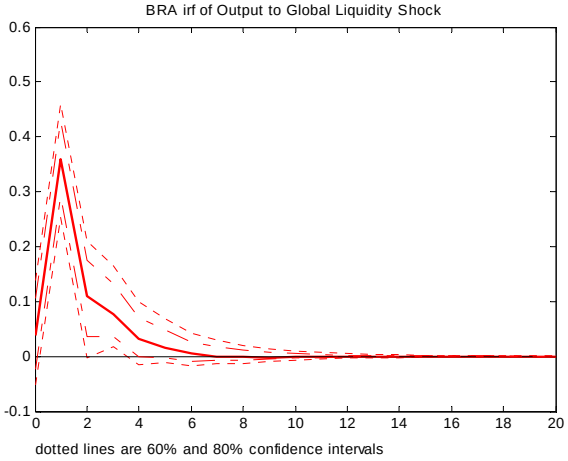
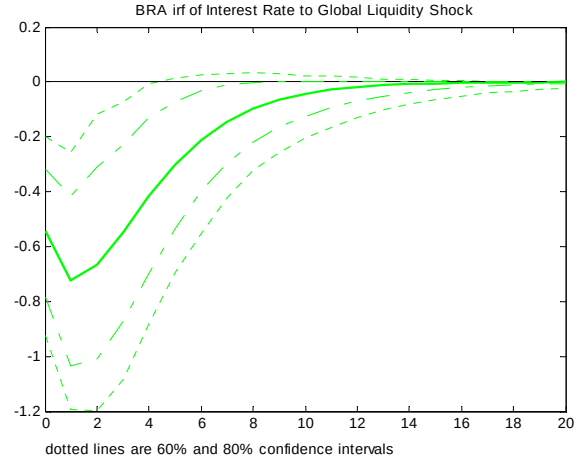


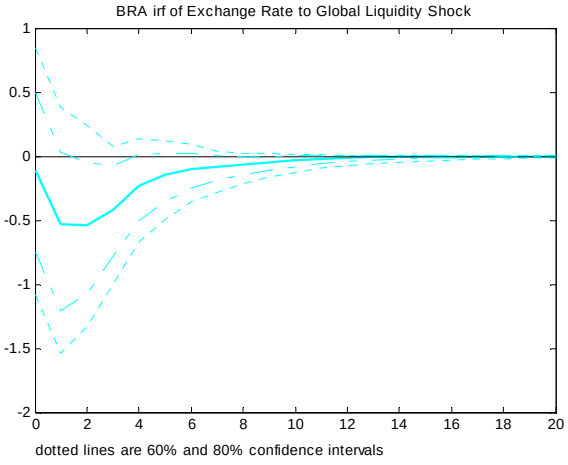
Figure 4: Brazil: Impulse Responses to Global Liquidity Shock (World Reserve)











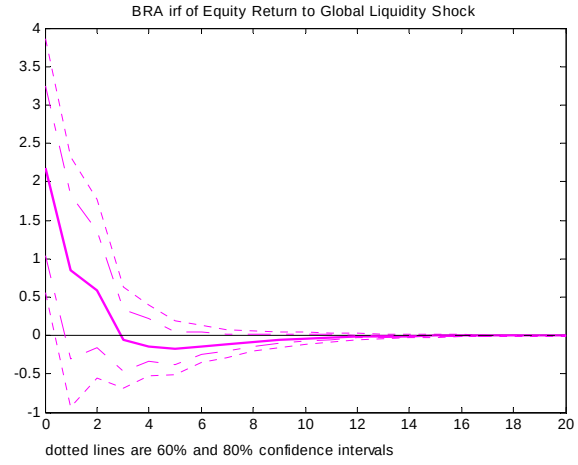
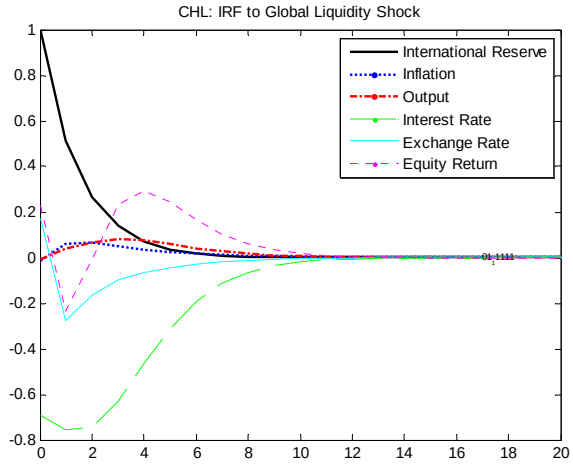
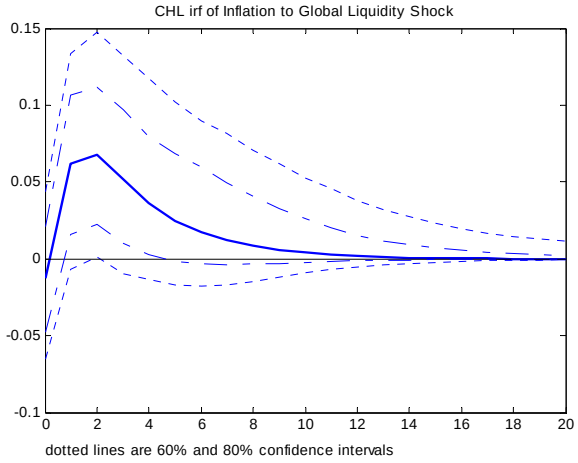
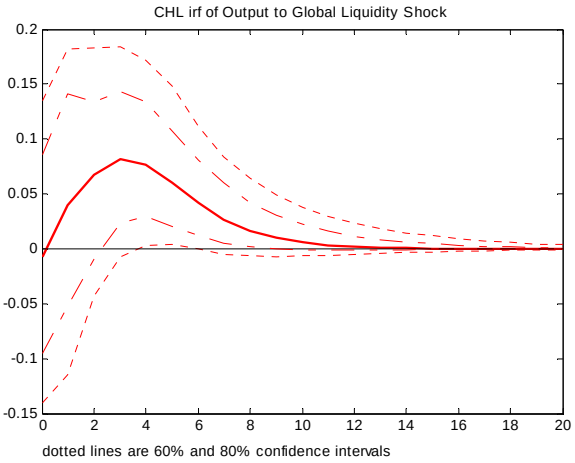
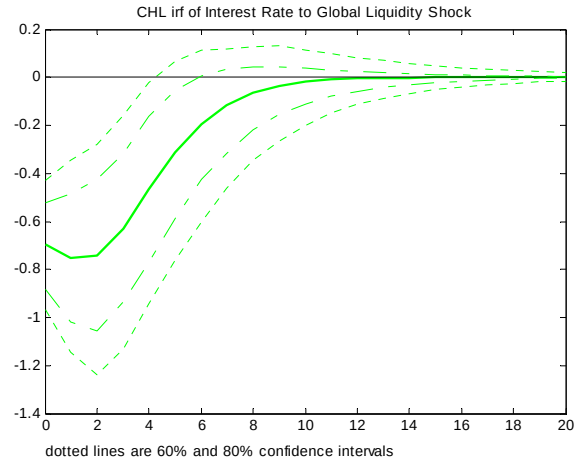


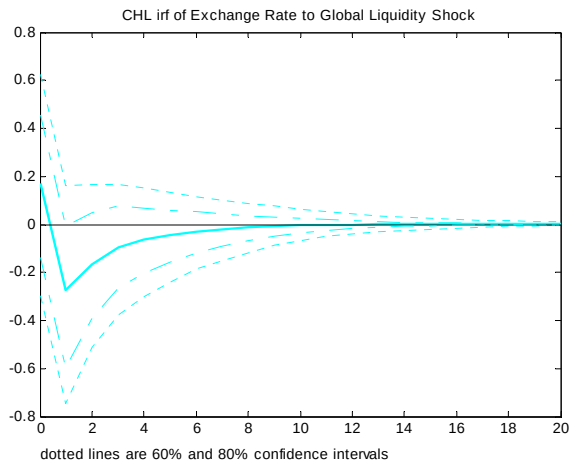
Figure 5: Chile: Impulse Responses to Global Liquidity Shock (World Reserve)











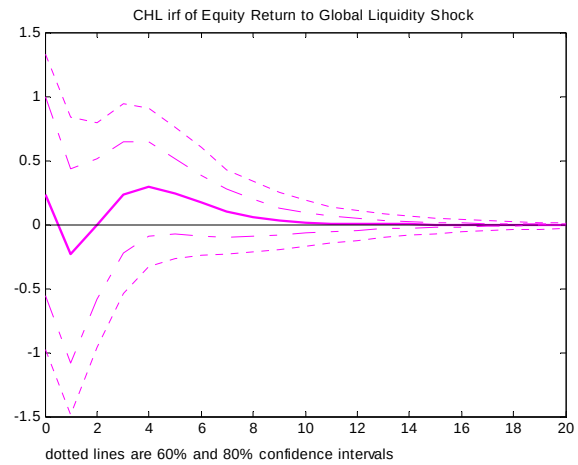
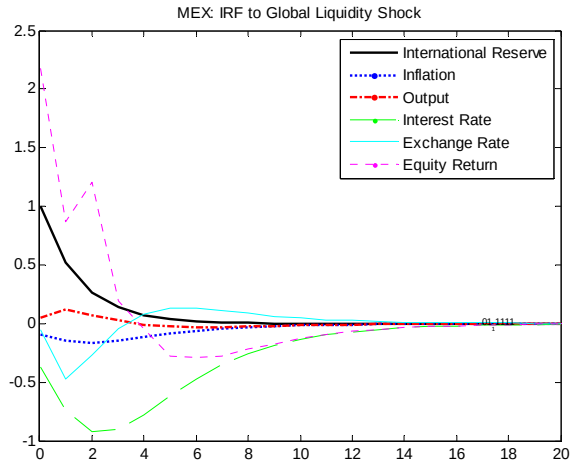
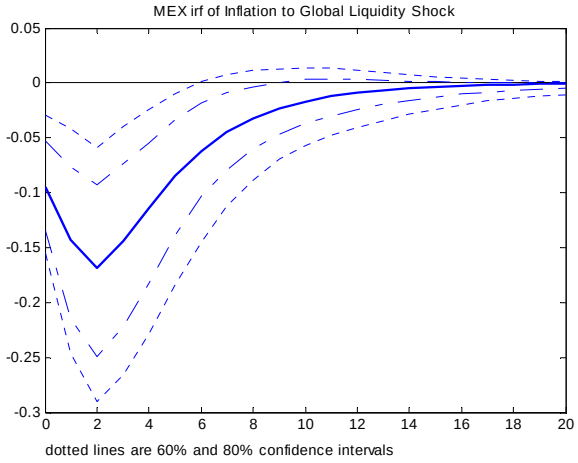
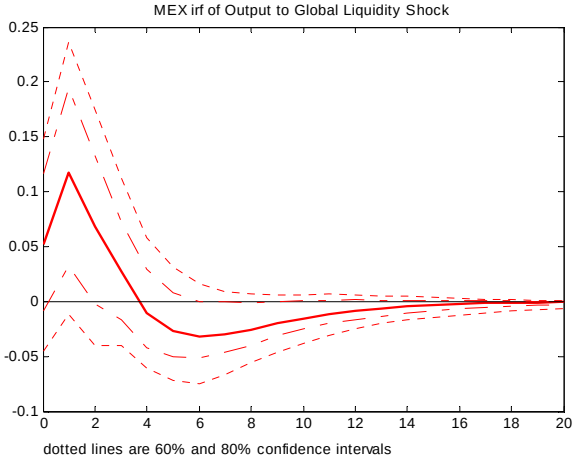
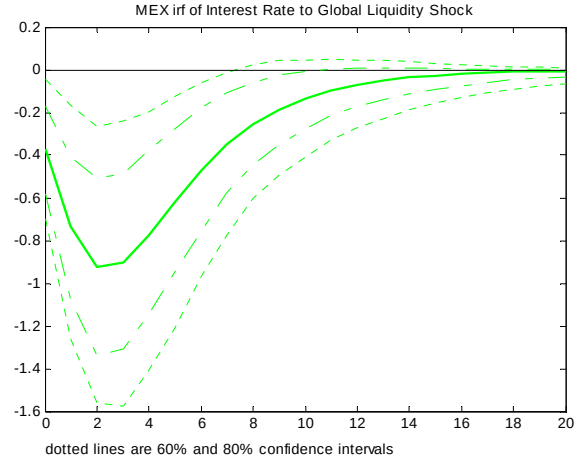


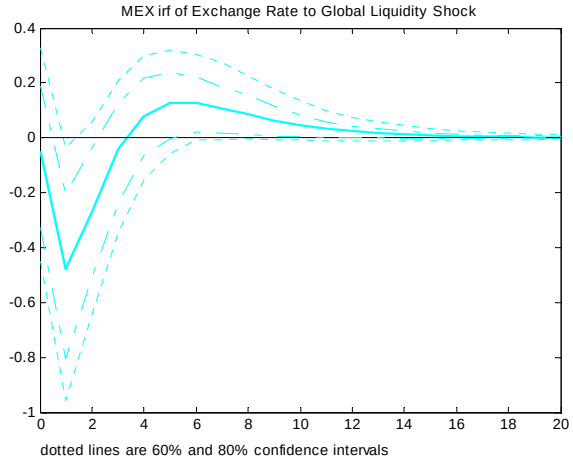
Figure 6: Mexico: Impulse Responses to Global Liquidity Shock (World Reserve)











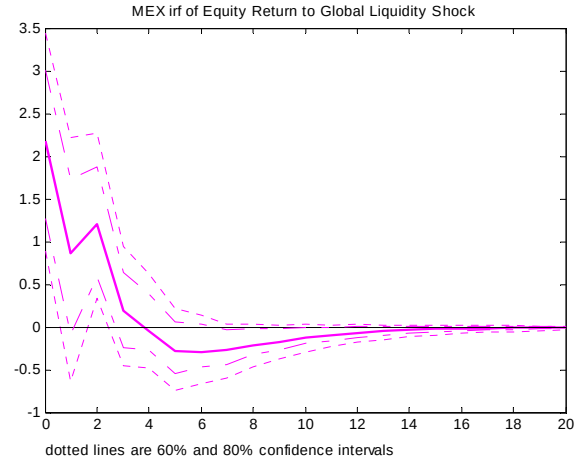


Figure 7: Argentina: Impulse Responses to Global Liquidity Shock (VIX)

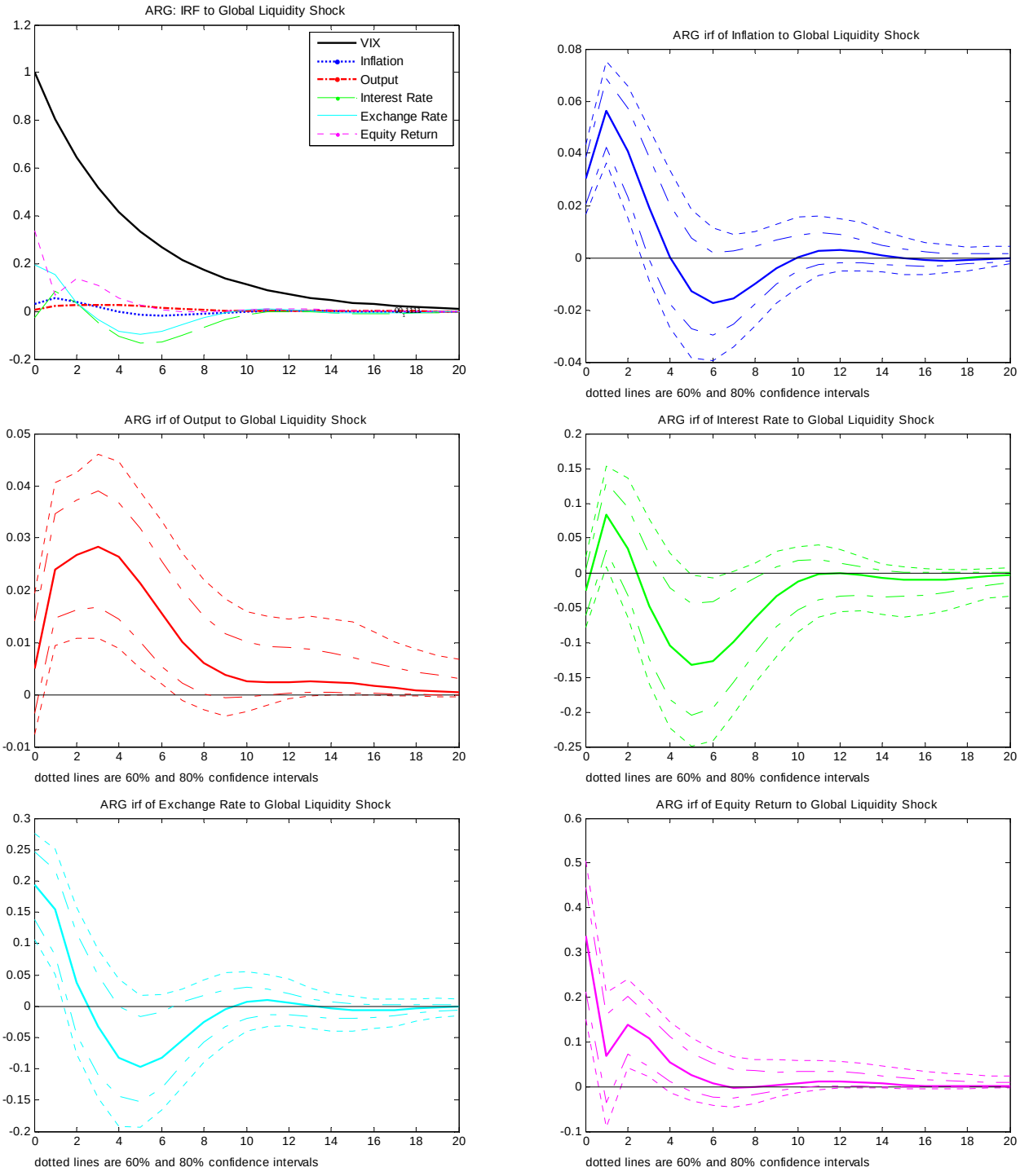


Figure 8: Brazil: Impulse Responses to Global Liquidity Shock (VIX)

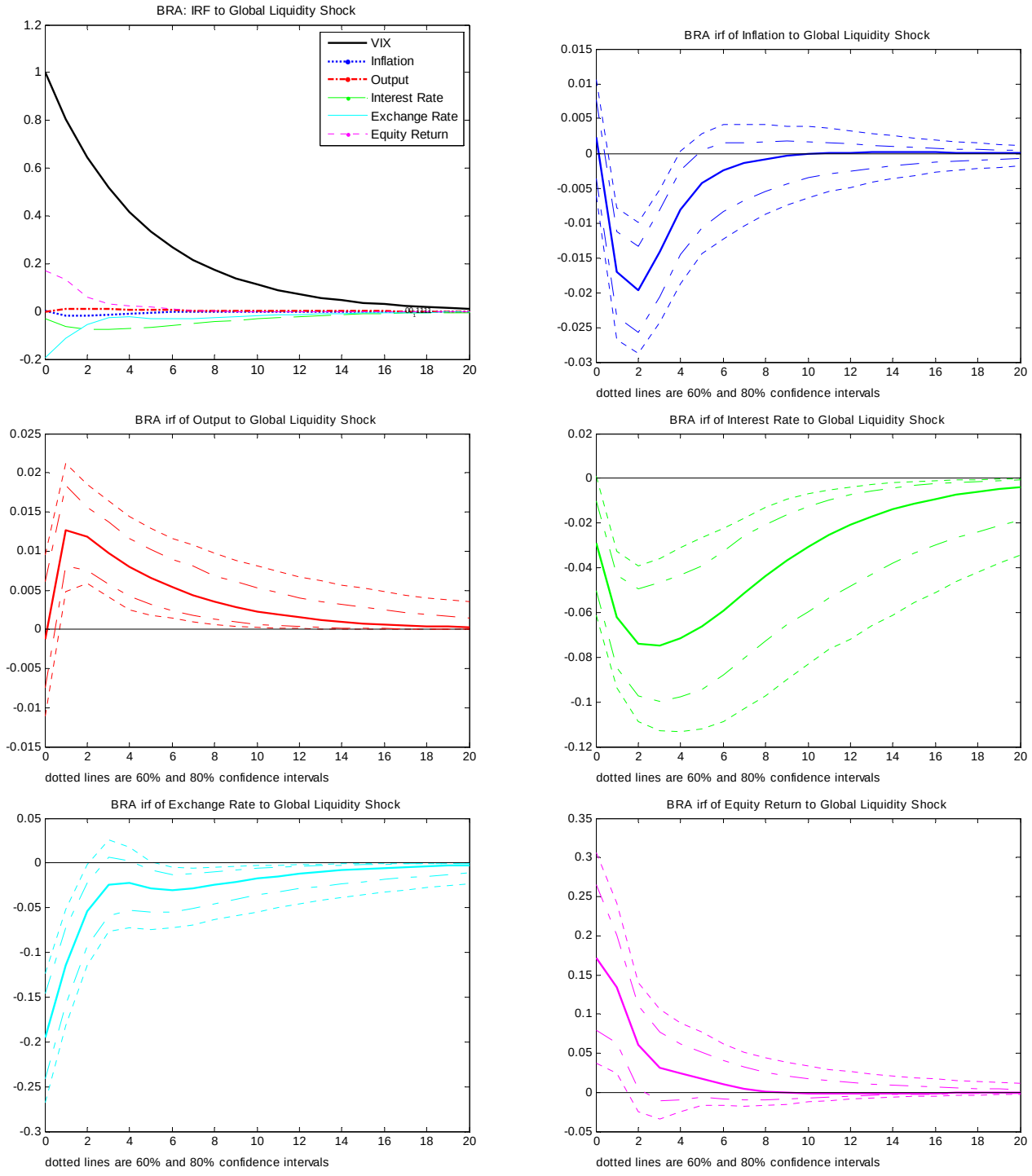


Figure 9: Chile: Impulse Responses to Global Liquidity Shock (VIX)

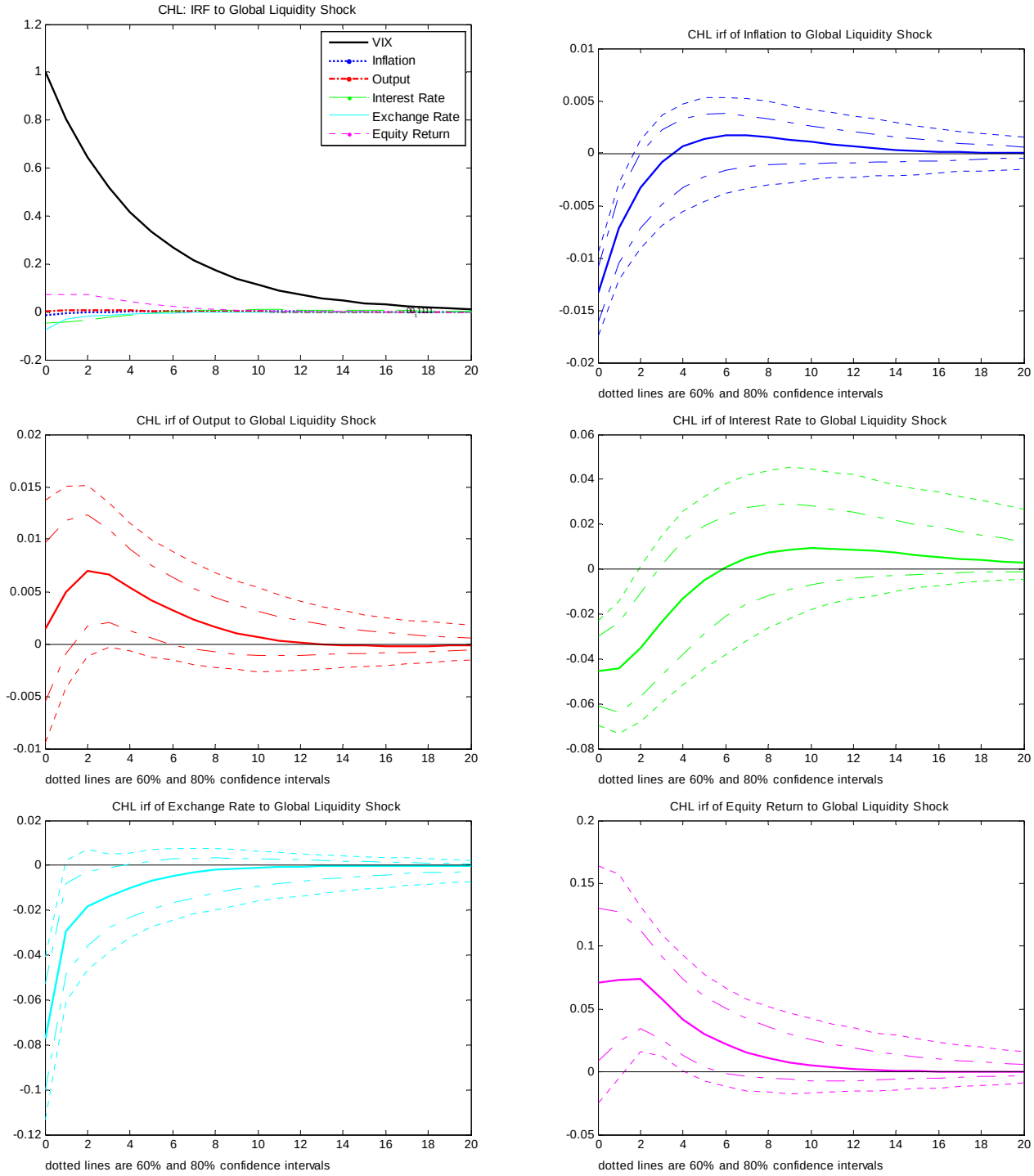
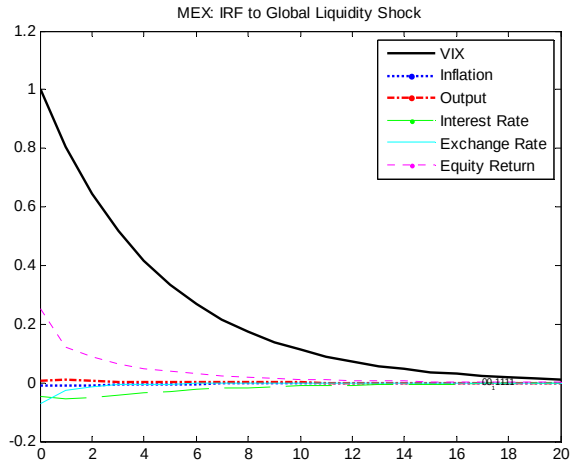
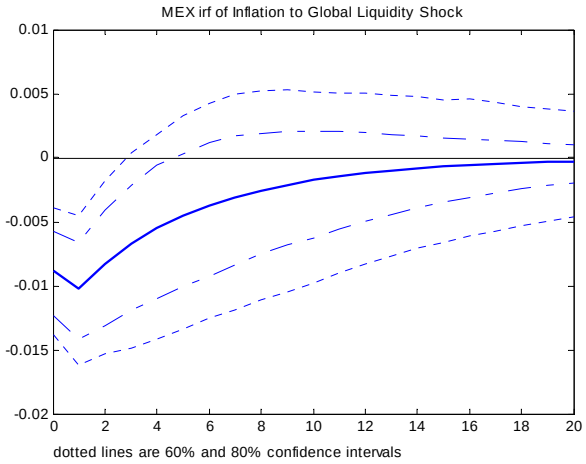
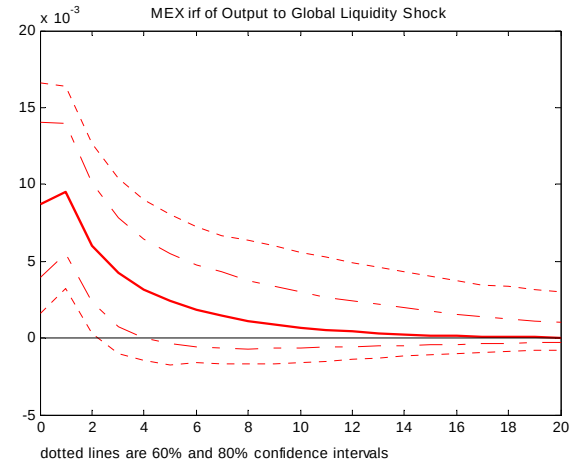
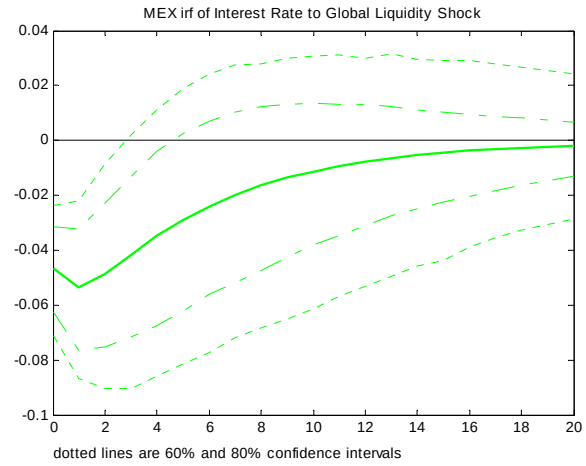


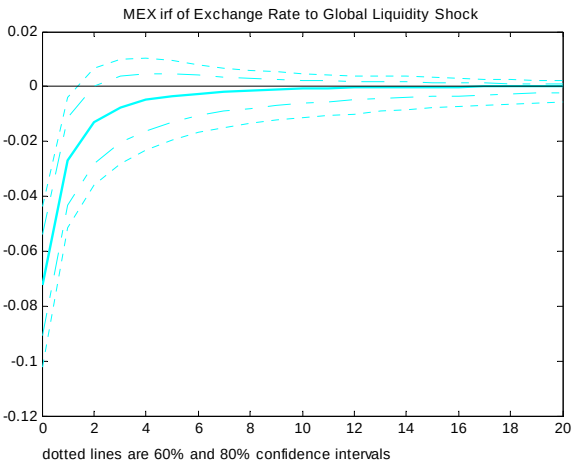
Figure 10: Mexico: Impulse Responses to Global Liquidity Shock (VIX)











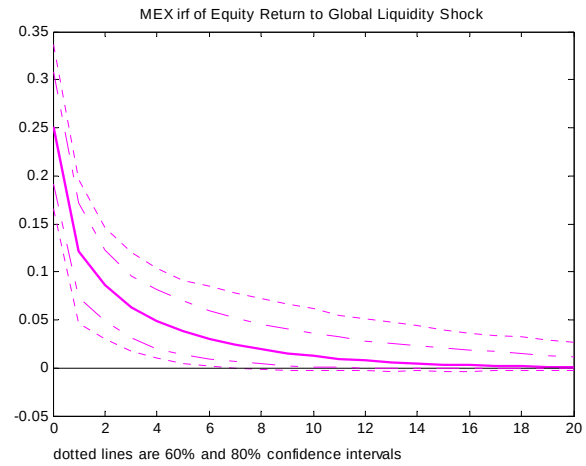


Figure 11: IRF to Global Liquidity Shock (TED)

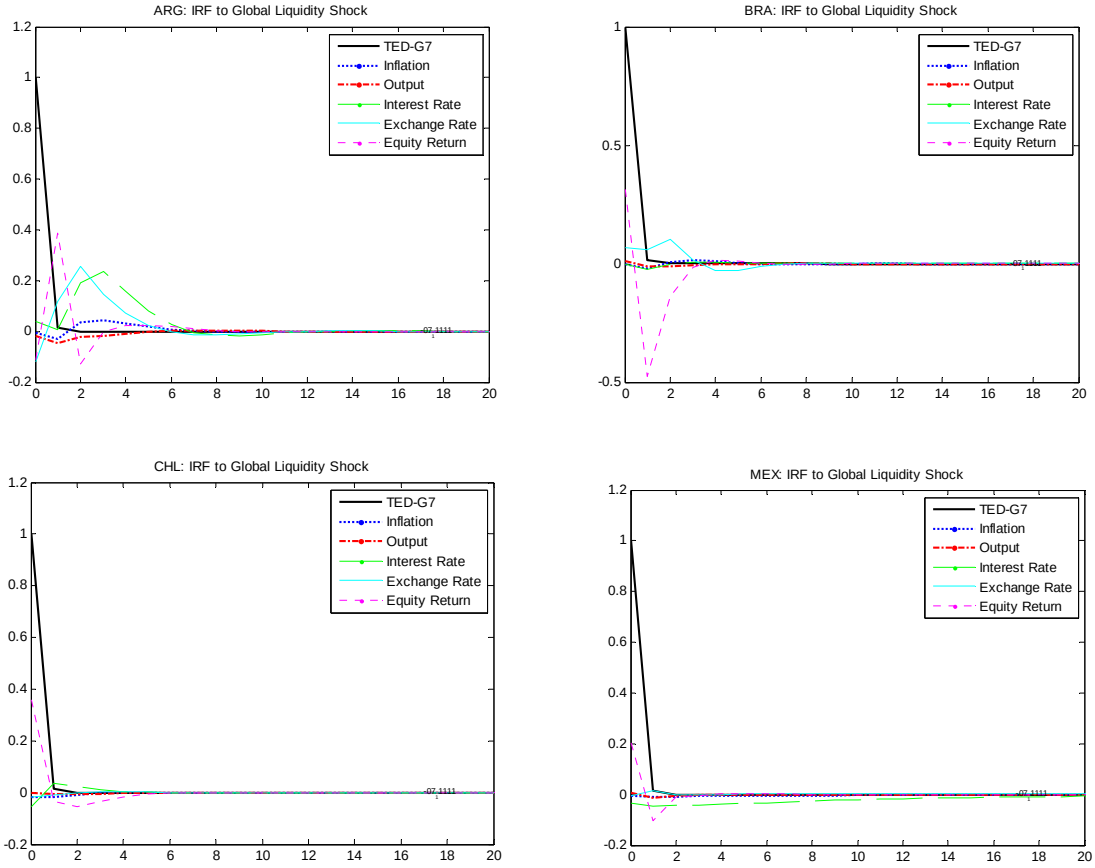


Figure 12: IRF to Exchange Rate Shock

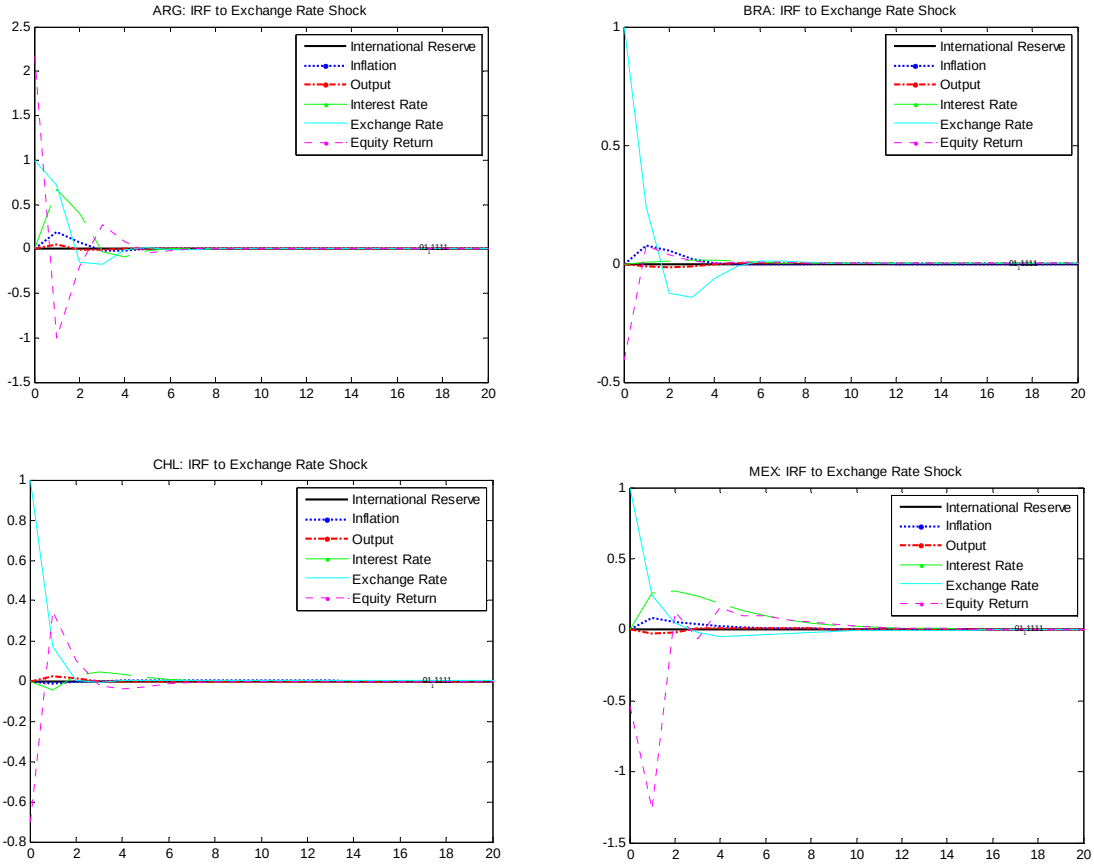
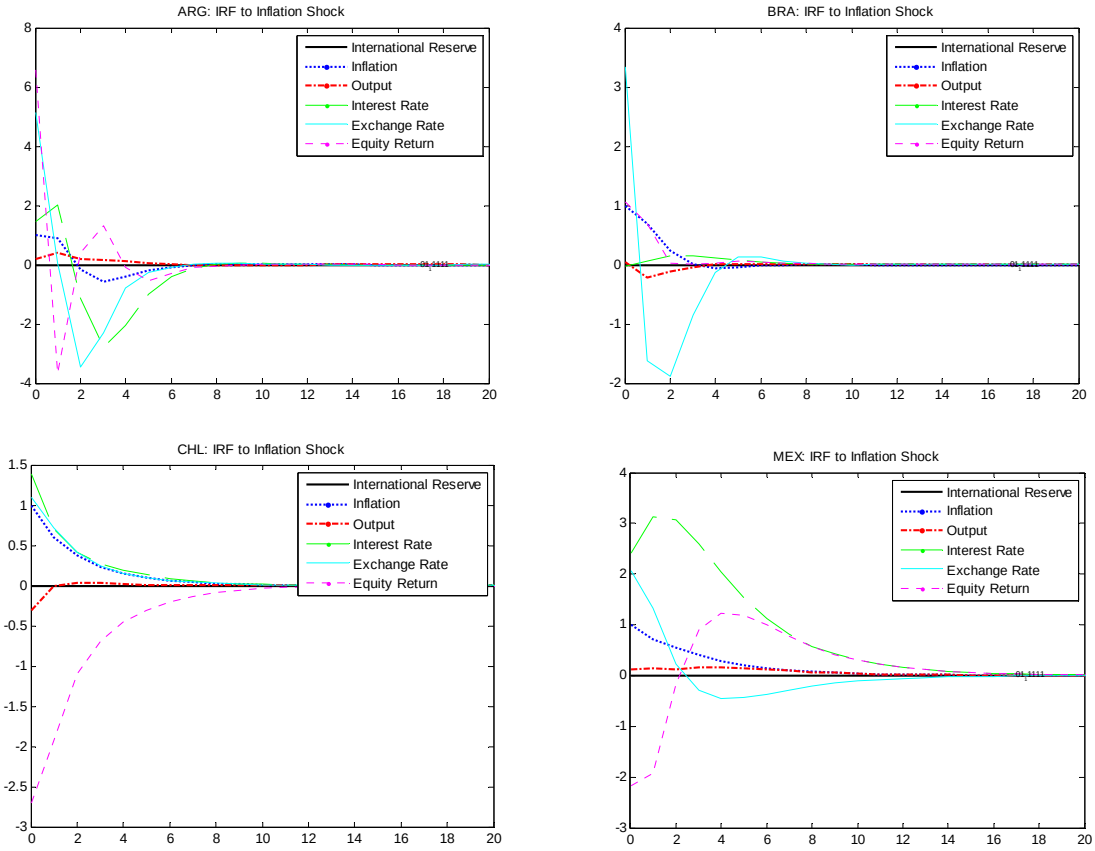


Figure 13: IRF to Inflation Shock



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