Box 4. A VAR Approach to Assessing the Real Impact of Global Liquidity

To explore the real economy impact of liquidity shocks, we use a VAR model similar to (1). We restrict our attention to the cumulative impulse response functions of real GDP growth rate over two, four and eight quarter horizons. These cumulative impulse responses are close approximations of the *level* changes in real GDP following a shock to global liquidity. The impulse responses of variable *i* to a one standard deviation shock in variable *j* are computed from (2) as:

$$IR(i,j,t) = q\Gamma^{t}\mathrm{A}s', \qquad (4)$$

where *q* and *s* are the selection vectors of appropriate size with 1 in the *i-th* and *j-th* elements and all other elements set to zero, Γ is the companion matrix of the VAR and $A = PQ$ from Section IV. To establish confidence intervals around the estimates of impulse responses, we follow the approach based on the bootstrap confidence intervals with adjustments for small sample sizes as proposed by Kilian (1998).[1] First, we collect the estimates of the VAR coefficients into a single vector $\hat{\beta} = \mathrm{vec}(B(L))$. Randomly resampling (with replacement) the residuals from the original estimation and simulating the process with the estimated coefficients $\hat{\beta}$ allows obtaining a thousand of additional samples and coefficient estimates. Denoting the average of these additional coefficient estimates by β^* allows estimating the bias of the bootstrap procedure as suggested by Kilian (1998):

$$\Delta = \beta^* - \hat{\beta} \qquad (5)$$

Such an approximation for bias is accurate to the first order and amounts to assuming that the OLS bias in regressions that include lagged dependent variable is constant in the neighborhood of $\hat{\beta}$. One can now proceed to construct the bias corrected estimate $\tilde{\beta}$ of the true model parameters β as follows: if all of the eigenvalues of the companion matrix associated with $\hat{\beta}$ are inside the unit circle, the bias corrected estimate is constructed as $\tilde{\beta} = \hat{\beta} - \Delta$, otherwise set $\tilde{\beta} = \hat{\beta}$. If any of the eigenvalues of the companion matrix associated with $\tilde{\beta}$ are outside the unit circle, one can further let $\delta_1 = 1$ and $\Delta_1 = \Delta$ and define $\Delta_{i+j} = \delta_j\Delta$ and $\delta_{j+1} = \delta_j - 0.01$. One can then iterate these equations and set $\tilde{\beta} = \hat{\beta} - \Delta_{i+j}$ for $j = 1,2,\ldots$ until all of the eigenvalues associated with the companion matrix with coefficients $\tilde{\beta}$ are inside the unit circle.

The second and final step of the algorithm involves using $\tilde{\beta}$ to generate further additional bootstrap samples, correcting them for bias and possible nonstationarity as above and hence obtaining the bias-corrected 90 percent confidence interval (using the 5-th and 95-th percentile of the bootstrap distribution of cumulative impulse responses) as well as the median estimate. The resulting confidence intervals of the impact of a one standard deviation shock to the supply or demand of core and noncore liquidity are summarized in Figures 12 through 15.

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[1]Other possible approaches include Monte Carlo integration methods, although our small sample size is a big limitation, and asymptotically valid confidence intervals, which uses a Bayesian (rather than frequent) approach.