The Role of Global Liquidity in Global Yield Dynamics

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With the emergence of global liquidity as an important factor in the global financial market since the global financial crisis in 2008, the global financial market has shown interest in the effect of global liquidity on global yield dynamics. This paper examines the role of global liquidity in global yield dynamics based on the macro-finance model. Estimation results show that the global liquidity plays a more important role in explaining the global level factor than global inflation, but such macro factors do not seem to explain the global slope factor. We interpret that global liquidity not only has information on global commodity inflation but also on global asset price inflation and future expected inflation and thus has more explanatory power than global inflation.

Keywords: Term structure, Global liquidity, Dynamic factor model, Global yield, Yield curve

JEL Classification: E4; C5; G1; F4

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I. Introduction

Policymakers, academics, and bond market participants have shown great interest in the structure of government bond yields and have generated a substantial amount of literature[1]. The key proposition is that yield curve is driven by a number of latent factors. In particular, three latent yield factors were suggested and interpreted as level, slope, and curvature in Andersen and Lund (1997), Diebold and Li (2006), and Diebold *et al.* (2008). Then, what are the economic insights on underlying latent factors or forces that drive changes in interest rates? To provide insight into the fundamental drivers of the yield curve, macro variables and macro structure have been combined with the finance models, namely, "Macro-finance models of interest rates"[2].

Diebold *et al.* (2008) provide a macroeconomic interpretation of the dynamic Nelson-Siegel representation of Diebold and Li (2006) by combining it with a vector autoregression representation for the macroeconomy. They show the existence of latent global yield factors and their connectedness with macroeconomic variables. In their estimation results, global level factor is correlated with global inflation, and global slope factor is highly correlated with global business cycle (real activity).

This paper considers another macroeconomic factor, namely, global liquidity. As the deepening of financial integration and cross-border lending has increased capital inflow and the financial dependence between economies, global liquidity has become a key focus of financial stability and goods and assets price inflation. It reflects a perception that global liquidity is an important driver of capital flows, global asset price dynamics, and inflation. D'agostino and Surico (2009) show that global liquidity has more predictive power for forecasting U.S. inflation than U.S. money growth. Belke *et al.* (2012) support the hypothesis that a positive long-run relation exists between global liquidity and the

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[1] Examples include Ang and Piazessi (2003), Ang *et al.* (2006), Bae and Kim (2011), Bekaert *et al.* (2010), Dewachter and Lyrio (2006), Dewachter *et al.* (2014), Diebold *et al.* (2005), Diebold and Li (2006), Diebold *et al.* (2006), Diebold *et al.* (2008), Paccagnini (2016), Rudebusch and Wu (2007, 2008), Wright (2011), and others.

[2] Please refer to Rudebusch (2010) for an excellent summary on the macro-finance models of interest rates.

development of food and commodity prices. Chen *et al.* (2012) show that global liquidity conditions matter for economic and financial stability. Eickmeier *et al.* (2014) emphasize that global liquidity has been a potentially important factor in the build-up of the pre-crisis financial imbalances and in the spill-over effects of accommodative monetary conditions from the core advanced to emerging market economies and suggest that global liquidity conditions are largely driven by three common factors—global monetary policy, global credit supply, and global credit demand[3]. Kang *et al.* (2016) find that the effect of global liquidity on commodity prices becomes more salient since the global financial crisis in 2008. Abbritti *et al.* (2018) show that global factors are the ultimate drivers of both yield curve and term premium dynamics across countries. Kim (2021) emphasizes the role of global factor in the global economic fluctuation and states the linkage between global factor and financial openness. We understand that such global factor would be linked with global yield dynamics and global liquidity.

Thus, global liquidity may play an important role in explaining cross-border interest dynamics. In this paper, we tackle the question of whether global liquidity has an impact on global yield dynamics. To this end, we consider the dynamic factor Nelson-Siegel model of Diebold *et al.* (2008) and incorporate three macro variables—global inflation, global business cycle, and global liquidity—into the model. In the empirical study, we consider the yield curves of four economies—Germany, Japan, U.K., and U.S.—covering the first quarter in 1985 to the second quarter in 2020.

Our estimation results show that global liquidity plays an important role in global level factor but not in global slope factor. In particular, when we incorporate global liquidity into the dynamic Nelson-Siegel factor model, global inflation is no longer a key factor in explaining global level factor. We interpret that global liquidity not only has the information on global commodity inflation but also the information on global asset price inflation and expected future inflation. However, global liquidity does not seem to play an important role in global slope factor, indicating that only global business cycle is linked to global slope factor as shown in the existing literature.

[3] Please refer to Ruffer and Stracca (2006), Sousa and Zaghini (2008), Belke *et al.* (2010), Domanski *et al.* (2011), CGFS (2011), Beckmann *et al.* (2014), Bruno and Shin (2015), and others for various issues related to global liquidity.

The remainder of the paper is structured as follows: Section II describes our estimation methodology, Section III presents the data and shows the estimation results, and Section IV concludes.

II. Methodology

A. Multi-country dynamic factor Nelson-Siegel model

The extraction of global yield factors has seen significant development. Diebold *et al.* (2008) have attempted to extend the dynamic factor Nelson-Siegel model (hereafter DFNS model; Diebold and Li 2006) for an individual country to the multi-countries model. Meanwhile, Abbritti *et al.* (2018) have applied the FAVAR model (Factor Augmented VAR) to the Macro-Finance model. In this paper, we consider the generalized DFNS model of Diebold *et al.* (2008) and incorporate not only global inflation and global business cycle but also global liquidity into the DFNS model. This modeling is similar to those of Ang and Piazessi (2003) and Diebold *et al.* (2008) who incorporated the macro factors into the macro-finance model. The key difference between these models and our model is that we consider the role of global liquidity in the macro factors, whereas they do not.

Diebold and Li (2006)'s dynamic factorization of the Nelson-Siegel yield curve for a single country can be written as follows:

$$y_{it}(\tau) = l_{it} + s_{it}(\frac{1-e^{\lambda_{it}\tau}}{\lambda_{it}\tau}) + c_{it}(\frac{1-e^{\lambda_{it}\tau}}{\lambda_{it}\tau} - e^{\lambda_{it}\tau}) + \nu_{it}(\tau), \tag{1}$$

where $y_{it}(\tau)$ denotes the continuously compounded zero-coupon nominal yield on a τ month bond for a country i at time t; l_{it}, s_{it}, and c_{it} are the three latent factors (slope, level, and curvature); λ_{it} is a parameter which determines the maturity at which the curvature loading is maximized; and $\upsilon_{it}(\tau)$ is a disturbance with standard deviation $\sigma_i(\tau)$. Following Diebold *et al.* (2008), we consider a simplified version of yield curve (1) where the curvature factor (c_{it}) is left out[4]. We also assume that λ_{it} is

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[4] Diebold *et al.* (2008) focus on the model with level and slope factors only because the curvature factor is normally estimated with low precision due to missing data at very short and/or very long maturities in most of the countries used in their study and because curvature lacks clear links to macroeconomic

constant over countries and time with little loss of generality from doing so. Then, Equation (2) can be rewritten as follows:

$$y_{it}(\tau) = l_{it} + s_{it}(\frac{1-e^{\lambda\tau}}{\lambda\tau}) + \nu_{it}(\tau). \tag{2}$$

Notably, Equation (2) is the effective measurement equation of a state space system with state vector $(l_{it}, s_{it})'$.

Now, following Diebold *et al.* (2008), we consider an N-country framework and introduce the global yields which depend on the global yield factors; thus, global yield can be expressed as follows:

$$Y_t(\tau) = L_t + S_t(\frac{1-e^{\lambda\tau}}{\lambda\tau}) + V_t(\tau), \tag{3}$$

where the $y_t(\tau)$ are global yields, and L_t *and* S_t are global yield factors (level and slope). We allow the dynamic movements of L_t *and* S_t which follow a first-order autoregressive process:

$$\begin{pmatrix} L_t \\ s_t \end{pmatrix} = \begin{pmatrix} \phi_{11} & \phi_{12} \\ \phi_{21} & \phi_{22} \end{pmatrix} \begin{pmatrix} L_{t-1} \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} U_t^L \\ U_t^s \end{pmatrix}, \tag{4}$$

where the U_t^n are disturbances such that $\mathrm{E}\left(U_t^n U_{t'}^{n'}\right) = (\sigma^n)^2$ if $t = t'$ and $n = n'$, and 0 otherwise, $n = L,S$. To characterize country common factors, namely, l_{it} *and* s_{it}, we allow l_{it} *and* s_{it} to load on global factors L_t *and* S_t as well as country idiosyncratic factors:

$$l_{it} = \alpha_i^l + \beta_i^l L_t + \varepsilon_{it}^l, \tag{5}$$

$$s_{it} = \alpha_i^s + \beta_i^s S_t + \varepsilon_{it,}^s \tag{6}$$

where $\{\alpha_i^l, \alpha_i^s\}$ are constant terms, $\{\beta_i^l, \beta_i^s\}$ are loadings on global factors, and $\{\varepsilon_{it}^l, \varepsilon_{it}^s\}$ are country idiosyncratic factors, i = 1, ... ,N. In Equations (5) and (6), constant terms exist; thus, we assume that country idiosyncratic factors have zero mean. In addition, following Diebold *et al.* (2008), considering that the magnitudes of global factors and factor

fundamentals.

loadings are not separately identified, we assume that innovations to global factors have unit standard deviation, that is,
$\sigma^n = 1$, $n = L,S$.

As the case of global factors, we allow country idiosyncratic factors to follow a first-order autoregressive process:

$$\begin{pmatrix} \varepsilon^l_{it} \\ \varepsilon^s_{it} \end{pmatrix} = \begin{pmatrix} \psi_{11} & \psi_{12} \\ \psi_{21} & \psi_{22} \end{pmatrix} \begin{pmatrix} \varepsilon^l_{it-1} \\ \varepsilon^s_{it-1} \end{pmatrix} + \begin{pmatrix} u^l_{it} \\ u^s_{it} \end{pmatrix}, \tag{7}$$

where the u^n_{it} are disturbances such that $\mathrm{E}(u^n_{it}u^{n'}_{it'}) = (\sigma^n_i)^2$ *if* $i = i'$, $t = t'$ *and* $n = n'$ and 0 otherwise, $n = l,s$. Moreover, we assume that $\mathrm{E}(U^n_t u^{n'}_{it-s})$ = 0, for all n, n', i, *and* s, which means the shocks to global factors and those to country-specific factors are orthogonal. We restrict that the dynamic matrices in Equations (4) and (7) are diagonal as in the case of Diebold *et al.* (2008).

We employ two step estimations to estimate Equations (1)–(7). In the first step, we consider four countries, namely, the US, Germany, Japan, and the UK and estimate l_{it} *and* s_{it}, for each country in Equation (2). We set $\lambda = 0.0609$.[5] Then, we can estimate the factor loading for country i at time t by ordinary least squares regressions for each country as in Diebold and Li (2006). In the second step, given the estimate of l_{it} *and* s_{it}, we estimate the global yield curve factor model by exploiting its state-space structure for both parameter estimation and factor extraction. In the state-space form, Equations (5) and (6) are measurement equations, and Equations (4) and (7) are transition equations. Here, we can estimate the factor-by-factor model in the second step by assuming that the dynamic matrices in Equations (4) and (7) are diagonal. All the parameters to be estimated for each factor are one autoregressive coefficient of the global factor (ϕ_{nn}, $n = 1, 2$), four constant terms (α^n_i, *i = US, Germany, Japan & UK,* $n = l,s$), four individual country loadings on the global factor (β^n_i, *i = US, Germany, Japan & UK,* $n = l,s$), four autoregressive coefficients on the country idiosyncratic factor (ψ^n_{ii}, *i = US,*

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[5] Diebold and Li (2006) attempt to find an appropriate value of λ_{it} in Equation (1) by recalling that λ_{it} determines the maturity at which the loading on the medium-term or curvature factor achieves it maximum. They regard two- or three-year maturities as medium-term and thus simply pick the average of 30 months. They show that λ_{it} value that maximizes the loading on the medium-term factor at exactly 30 months is $\lambda_{it} = 0.0609$.

Germany, Japan & UK, n = *l,s*), and four standard deviations of the country idiosyncratic factor (σ^n_{ii}, *i* = *US, Germany, Japan & UK, n* = *l,s*). Therefore, the total parameters are 17 for each factor. The state-space model for the level factor can be rewritten as follows:

$$\begin{pmatrix} l_{US,t} \\ l_{GM,t} \\ l_{JP,t} \\ l_{UK,t} \end{pmatrix} = \begin{pmatrix} \alpha^l_{US} \\ \alpha^l_{GM} \\ \alpha^l_{JP} \\ \alpha^l_{UK} \end{pmatrix} + \begin{pmatrix} \beta^l_{US} & 1 & 0 & 0 & 0 \\ \beta^l_{GM} & 0 & 1 & 0 & 0 \\ \beta^l_{JP} & 0 & 0 & 1 & 0 \\ \beta^l_{UK} & 0 & 0 & 0 & 1 \end{pmatrix} + \begin{pmatrix} L_t \\ \varepsilon^l_{US,t} \\ \varepsilon^l_{GM,t} \\ \varepsilon^l_{JP,t} \\ \varepsilon^l_{UK,t} \end{pmatrix}, \tag{8}$$

$$\begin{pmatrix} L_t \\ \varepsilon^l_{US,t} \\ \varepsilon^l_{GM,t} \\ \varepsilon^l_{JP,t} \\ \varepsilon^l_{UK,t} \end{pmatrix} = \begin{pmatrix} \phi_L & 0 & 0 & 0 & 0 \\ 0 & \psi^l_{US} & 0 & 0 & 0 \\ 0 & 0 & \psi^l_{GM} & 0 & 0 \\ 0 & 0 & 0 & \psi^L_{JP} & 0 \\ 0 & 0 & 0 & 0 & \psi^L_{UK} \end{pmatrix} \begin{pmatrix} L_{t-1} \\ \varepsilon^l_{US,t-1} \\ \varepsilon^l_{GM,t-1} \\ \varepsilon^l_{JP,t-1-1} \\ \varepsilon^l_{UK,t-1} \end{pmatrix} + \begin{pmatrix} u_{L,t} \\ u^l_{US,t} \\ u^l_{GM,t} \\ u^l_{JP,t} \\ u^l_{UK,t} \end{pmatrix}, \quad u_t \sim iidN(0,\Omega), \tag{9}$$

where Equation (8) is a measurement equation, and Equation (9) is a transition equation. Following Diebold *et al.* (2008), we set the valid initial value and estimate the parameters in the model by using the constrained MLE given the condition that the factor dynamics stationarity has to be satisfied[6].

B. Multi-country dynamic factor Nelson-Siegel model with macro-variables

We extend the multi-country dynamic factor Nelson-Siegel model by incorporating the macro variables, namely, global inflation, global business cycle, and global liquidity. Diebold *et al.* (2008) only consider global inflation and global business cycle, whereas we consider not only two macro variables but also global liquidity. As in the case of the multi-country DFNS model, we employ a two-step estimation procedure. In the first step, we extract the level and the slope factors by using the OLS regression. Following Ang and Piazessi (2003), we apply the principal component analysis (PCA) to inflation, business cycles,

[6] Please refer to Kim and Nelson (1999) for the model specification and its estimation.

and liquidity variables for individual country and extract principal components. We regard the first principal component in each PCA as the global inflation factor (f_{INF}), the global business cycle factor (f_{BUSS}), and the global liquidity factor (f_{LIQ})[7]. In the second step, following Diebold *et al.* (2006), we consider the state-space model with the macro factors which are extracted from the PCA as follows:

$$\begin{pmatrix} l_{US,t} \\ l_{GM,t} \\ l_{JP,t} \\ l_{UK,t} \\ f_{INF,t} \\ f_{BUSS,t} \\ f_{LIQ,t} \end{pmatrix} = \begin{pmatrix} \alpha_{US,t} \\ \alpha_{GM,t} \\ \alpha_{JP,t} \\ \alpha_{UK,t} \\ 0 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 & 0 & \beta^l_{US} & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta^l_{GM} & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & \beta^l_{JP} & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & \beta^l_{UK} & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} f_{INF,t} \\ f_{BUSS,t} \\ f_{LIQ,t} \\ L_t \\ \varepsilon^l_{US,t} \\ \varepsilon^l_{GM,t} \\ \varepsilon^l_{JP,t} \\ \varepsilon^l_{UK,t} \end{pmatrix}, \qquad (10)$$

$$\begin{pmatrix} f_{INF,t} \\ f_{BUSS,t} \\ f_{LIQ,t} \\ L_t \\ \varepsilon^l_{US,t} \\ \varepsilon^l_{GM,t} \\ \varepsilon^l_{JP,t} \\ \varepsilon^l_{UK,t} \end{pmatrix} = \begin{pmatrix} \theta_{11} & \theta_{12} & \theta_{13} & \varphi_{L,INF} & 0 & 0 & 0 & 0 \\ \theta_{21} & \theta_{22} & \theta_{23} & \varphi_{L,BUSS} & 0 & 0 & 0 & 0 \\ \theta_{31} & \theta_{32} & \theta_{33} & \varphi_{L,LIQ} & 0 & 0 & 0 & 0 \\ \varphi_{INF,L} & \varphi_{BUSS,L} & \varphi_{LIQ,L} & \phi_L & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \psi^l_{US} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \psi^l_{GM} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \psi^l_{JP} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & \psi^l_{UK} \end{pmatrix} \begin{pmatrix} f_{INF,t-1} \\ f_{BUSS,t-1} \\ f_{LIQ,t-1} \\ L_{t-1} \\ \varepsilon^l_{US,t-1} \\ \varepsilon^l_{GM,t-1} \\ \varepsilon^l_{JP,t-1} \\ \varepsilon^l_{UK,t-1} \end{pmatrix} + \begin{pmatrix} u^l_{INF,t} \\ u^l_{BUSS,t} \\ u^l_{LIQ,t} \\ u^l_{L,t} \\ u^l_{US,t} \\ u^l_{GM,t} \\ u^l_{JP,t} \\ u^l_{UK,t} \end{pmatrix},$$

$$u_t \sim iidN(0, \Omega), \qquad (11)$$

where Equation (10) is a measurement equation, and Equation (11) is a transition equation. Ang and Piazessi (2003) estimate the coefficients to show the relationship between macro factors, θ_{ij}, i & $j = 1,2,3$, and their variances by the OLS and then fix these values in the model. Next, they estimate other parameters given these fixed values. Here,

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[7] After we regard the first principal component as the inflation factor in the inflation data, we regress the business cycle data on the inflation factor and consider the first principal component of the residual as the business cycle factor. Similarly, we regress the liquidity data on the inflation and business cycle factors and identify the first principal component of the residual as the liquidity factor. This process makes three factors orthogonal. The estimation result for the PCA is shown in the <Appendix 1>.

we employ Ang and Piazessi (2003)'s methodology. That is, we estimate θ_{ij}, i & $j = 1,2,3$ and three covariances of the macro-factors in Ω in the each model and then estimate other parameters given that these values are fixed. Additionally, we allowed the interaction between the global yield factors and the global macro factors but assume that the country-specific yield factors are independent of the global macro factors. We also assume that the country-specific yield factors are orthogonal to each other.[8] In this estimation process, we have a total of 26 parameters to be estimated: 17 parameters in the multi-country global yield model, 6 coefficients on the relationship between the global yield and the global macro-factors, and 3 covariances between the global yield factor and the global macro-factors. Based on the estimation result of the multi-country global yield model, we set the initial value and estimate all parameters by using the constrained MLE to satisfy the stationarity condition of the factor dynamics.

III. Estimation results

A. Data

We consider four countries, namely, the US, Germany, Japan, and the UK; and the data for the interest rate are the quarterly zero-coupon bond yield of 3, 6, 9, 12, 15, 18, 21, 24, 30, 36, 48, 60, 72, 84, 96, 108, and 120 months from the first quarter in 1985 to the second quarter in 2020[9]. The data for the global inflation are the CPI and GDP deflator of the US, Germany, Japan, and the UK. The data on the global business cycle are the GDP and the industrial production index for four countries. We use OECD's data on the global inflation and the global

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[8] In the $\boldsymbol{\Omega}_{(8,8)} = \begin{pmatrix} \boldsymbol{Q}_{m,(4,4)} & \boldsymbol{0}_{(4,4)} \\ \boldsymbol{0}_{(4,4)} & \boldsymbol{Q}_{c,(4,4)} \end{pmatrix}$, $\boldsymbol{Q}_c$ is a diagonal matrix, the first (3×3) matrix in $\boldsymbol{Q}_m$ are the values to be pre-estimated, the variance of the global yield factor is an unity; thus, the total of 7 parameters are estimated in $\boldsymbol{\Omega}$.

[9] The interest rate data from Q1 in 1985 to Q1 in 2009 are from Wright (2011), and the interest rate data from Q2 in 2009 to Q2 in 2020 are from Bloomberg because Wright's data are only available by May in 2009, whereas Bloomberg's data are available from 1995. We compare the statistical characteristics of two different data over the common period of 1995 Q1–2008 May and find that two interest rates are nearly same. Moreover, the interest rates of 9, 15, 18, 21, and 30 months in the Bloomberg are unavailable. Accordingly, we calculate the zero-coupon bond yields using the cubic spline interpolation.

Table 1

Descriptive statistics for bond yields

maturity(months)	Mean	Std. Dev	Minimum	Maximum	ρ(1)	ρ(4)	ρ(12)
US							
3	3.232	2.512	0.016	8.90	0.963	0.819	0.482
12	3.643	2.726	0.096	9.568	0.958	0.828	0.531
60	4.521	2.574	0.303	11.211	0.941	0.819	0.678
120	5.170	2.395	0.647	11.603	0.938	0.808	0.707
Germany							
3	3.026	2.867	-0.897	10.021	0.974	0.889	0.627
12	3.101	2.783	-0.872	9.076	0.977	0.888	0.629
60	3.793	2.747	-0.796	9.238	0.973	0.891	0.715
120	4.359	2.598	-0.584	9.222	0.973	0.889	0.733
Japan							
3	1.453	2.298	-0.339	8.010	0.973	0.855	0.619
12	1.458	2.201	-0.321	8.433	0.968	0.857	0.608
60	1.905	2.137	-0.366	8.001	0.961	0.868	0.679
120	2.425	2.103	-0.226	7.692	0.964	0.884	0.712
UK							
3	5.176	4.309	-0.002	15.125	0.970	0.868	0.642
12	4.861	3.859	-0.032	14.088	0.971	0.877	0.679
60	5.221	3.414	-0.048	12.389	0.966	0.884	0.730
120	5.488	3.113	0.183	11.669	0.966	0.882	0.720

All yield data are quarterly, 1985:1q-2020:2q. ρ(τ) denotes the autocorrelation lag at τ.

business cycle.

Domanski *et al.* (2011) and Landau (2011) suggest using the credit-to-GDP and the broad money to measure global liquidity. In this study, we employ the credit-to-GDP ratio data for four countries which are collected from the BIS and the broad money data from OECD[10].

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[10] Chen *et al.* (2012) suggested using the combination of price (*e.g.* short-term rate) and quantity base variables to identify global liquidity. However, in this study, we analyze the dynamics of yield factors that are price base variables, and interest rates are strongly correlated to each other. If we incorporate the price variables to identify global liquidity, this process may cause spurious estimation results between the yield factors and global liquidity. Accordingly, we only use quantity base variables to identify global liquidity.

TABLE 2

DESCRIPTIVE STATISTICS FOR MACRO VARIABLES

	Mean	Std. Dev	Minimum	Maximum	ρ(1)	ρ(2)	ρ(4)
US							
GDP	2.554	1.890	-9.033	5.298	0.696	0.531	0.248
IP	1.878	3.908	-15.118	8.388	0.821	0.619	0.155
CPI	2.593	1.280	-1.607	6.276	0.841	0.647	0.324
Def	2.163	0.811	0.261	4.232	0.921	0.832	0.617
Credit	1.117	2.512	-4.916	6.382	0.943	0.865	0.705
Broad money	5.725	2.562	0.409	20.617	0.721	0.579	0.310
Germany							
GDP	1.690	2.377	-11.215	7.438	0.725	0.518	0.122
IP	1.485	5.660	-22.352	13.982	0.780	0.532	-0.033
CPI	1.735	1.181	-0.922	6.094	0.915	0.810	0.561
Def	1.683	1.204	-0.848	6.043	0.918	0.827	0.607
Credit	0.309	2.481	-7.762	7.129	0.880	0.725	0.360
Broad money	6.028	2.961	-1.549	12.126	0.947	0.860	0.648
Japan							
GDP	1.623	2.759	-10.334	9.369	0.751	0.566	0.192
IP	0.669	6.668	-30.802	23.192	0.753	0.398	-0.270
CPI	0.565	1.211	-2.213	3.709	0.874	0.747	0.432
Def	0.201	1.656	-3.149	4.965	0.749	0.669	0.441
Credit	0.129	3.186	-5.053	9.975	0.884	0.769	0.512
Broad money	3.466	3.222	-0.670	12.937	0.975	0.928	0.815
UK							
GDP	2.094	2.764	-20.800	6.974	0.546	0.386	0.186
IP	0.541	3.241	-18.927	7.974	0.689	0.497	0.166
CPI	2.831	1.789	0.334	9.219	0.947	0.861	0.687
Def	2.915	2.124	-1.767	9.946	0.815	0.743	0.594
Credit	2.298	4.324	-6.399	11.758	0.877	0.777	0.534
Broad money	8.255	5.679	-2.840	19.957	0.935	0.847	0.633

All macro data are quarterly, 1985:1q–2020:2q. ρ(τ) denotes the autocorrelation lag at τ.

B. Estimation results: Global yield-only model

Following Diebold *et al.* (2008), we estimate the yield-only model. <Table 3> shows the estimation results. As in the case of Diebold *et al.* (2008), the global level factor is highly serially correlated. The global level factor loadings in the country level factor equations are estimated with high precision. All level factors load positively on the global level

TABLE 3

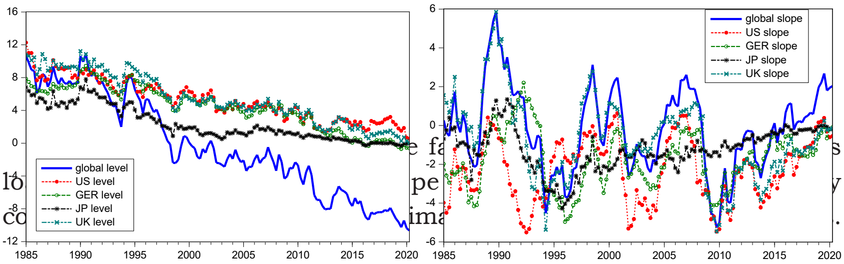
ESTIMATES OF THE GLOBAL YIELD ONLY MODEL PARAMETERS

global level factor	
$L_t = \mathbf{0.9679} L_{t\text{-}1} + U_t^l$ (0.0077)***	
country level factors	
$l_{US,t} = 5.4760 + \mathbf{0.4735} L_t + \varepsilon_{US,t}^l$ (3.3576) (0.0442)***	$\varepsilon_{US,t}^l = \mathbf{0.8841} \varepsilon_{US,t\text{-}1}^l + \mathbf{0.3825} u_{US,t}^l$ (0.0539)*** (0.0203)***
$l_{GM,t} = 4.2020 + \mathbf{0.4061} L_t + \varepsilon_{GM,t}^l$ (3.0541) (0.0299)***	$\varepsilon_{GM,t}^l = \mathbf{0.9669} \varepsilon_{GM,t\text{-}1}^l + \mathbf{0.1923} u_{GM,t}^l$ (0.0211)*** (0.0082)***
$l_{JP,t} = 2.4890 + \mathbf{0.3119} L_t + \varepsilon_{JP,t}^l$ (2.3301) (0.0299)***	$\varepsilon_{JP,t}^l = \mathbf{0.8433} \varepsilon_{JP,t\text{-}1}^l + \mathbf{0.3469} u_{JP,t}^l$ (0.0539)*** (0.0203)***
$l_{UK,t} = 5.5816 + \mathbf{0.5801} L_t + \varepsilon_{UK,t}^l$ (3.7849) (0.0380)***	$\varepsilon_{UK,t}^l = \mathbf{0.2861} \varepsilon_{UK,t\text{-}1}^l + \mathbf{0.2792} u_{UK,t}^l$ (0.1540)* (0.0156)***
global slope factor	
$S_t = \mathbf{0.9191} S_{t\text{-}1} + U_t^S$ (0.0365)***	
country slope factors	
$S_{US,t} = \mathbf{-2.3059} + \mathbf{0.4435} S_t + \varepsilon_{US,t}^S$ (0.7714)*** (0.0612)***	$\varepsilon_{US,t}^S = \mathbf{0.9292} \varepsilon_{US,t\text{-}1}^S + \mathbf{0.5163} u_{US,t}^S$ (0.0335)*** (0.0437)***
$S_{GM,t} = \mathbf{-1.6370} + \mathbf{0.3896} S_t + \varepsilon_{GM,t}^S$ (0.6034)*** (0.0519)***	$\varepsilon_{GM,t}^S = \mathbf{0.9317} \varepsilon_{GM,t\text{-}1}^S + \mathbf{0.4125} u_{GM,t}^S$ (0.0317)*** (0.0315)***
$S_{JP,t} = \mathbf{-1.1265} + \mathbf{0.1467} S_t + \varepsilon_{JP,t}^S$ (0.3727)*** (0.0417)***	$\varepsilon_{JP,t}^S = \mathbf{0.9053} \varepsilon_{JP,t\text{-}1}^S + \mathbf{0.4099} u_{JP,t}^S$ (0.0360)*** (0.0209)***
$S_{UK,t} = -0.4892 + \mathbf{0.5848} S_t + \varepsilon_{UK,t}^S$ (0.8480) (0.0733)***	$\varepsilon_{UK,t}^S = \mathbf{0.9285} \varepsilon_{UK,t\text{-}1}^S + \mathbf{0.5410} u_{UK,t}^S$ (0.0438)*** (0.0638)***

Note: a. The table reports the parameters and standard errors in parenthesis for the global yield-only model, and the bold entries denote statistically significant estimates.

b. ***, **, * denote statistically significant at the 1%, 5%, and 10%, respectively.

factor. The country-specific level factors are also generally highly persistent. The UK level loading on the global level factor is larger relative to the US and Germany, and the persistence of the UK-specific level factor is much smaller, implying that the dynamics of the UK yield level match closely those of the global factor. Conversely, the Japanese level loading on the global level factor is smaller relative to the US and Germany. The persistence of the Germany-specific level factor is larger relative to other three countries, implying that the German yield level is comparatively divorced from the global level.



a. global level factor and 4-country level factors

b. global slope and 4-country slope factors

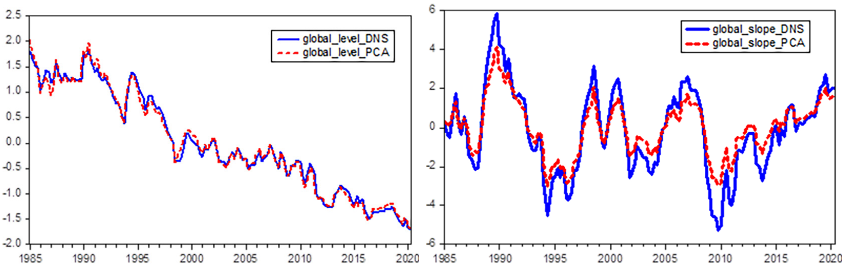
FIGURE 1

GLOBAL YIELD FACTORS AND COUNTRY-SPECIFIC YIELD FACTORS

The country-specific slope factors are also generally highly persistent. All slope factors load effectively on the global factor. The Japan slope loading on the global slope factor is smaller relative to those in the UK and the US, as in the case of the Japan level results. Overall, the Japanese yield level and slope loadings on the global level and slope factor appear to be a little different from other three countries.

Figures 1.a and 1.b show the estimated global yield factors and the four countries' yield factors. The global level and country-specific level factors appear to co-move roughly. The Japanese level factor shows a slightly different movement from other countries, which seems to be due to its relatively small influence on the global level factor. We can find a similar implication from Figure 1.b that the Japanese slope factor appears to be a little different from other countries.

To assess the commonality in country level and/or slope factor dynamics and the commonality of movements in country yield curves, we compare the global yield factor extracted with the first principal component which is estimated from a principal component analysis of the estimated level and slope factors. <Figure 2> plots the global level and slope factors extracted and the first PCA component. The correlations for the level factor and for the slope factor are 0.997 and 0.984, respectively. The global level factor extracted is nearly identical to the first principal level component, and this relation appears to be similar in the case of the global slope factor.



global level factor, correlation = 0.9969 global slope factor, correlation = 0.9841

Figure 2

Global Yield Factors From Global Yield Model And Pca(Normalized)

C. Estimation results: Global yield model with inflation and business cycle macro factors

Ang and Piazessi (2003), Diebold *et al.* (2006), and Diebold *et al.* (2008) show that latent country yield factors are linked to and interact dynamically with macroeconomic factors. In particular, Diebold et al. (2008) show that the extracted global level and slope factors reflect the major developments in global inflation and real activity. Diebold *et al.* (2008) and Bae and Kim (2011) show that the global level factor reflects the global inflation, and Abbritti *et al.* (2018) state that the global level factor is closely related with the expected inflation. In addition, Diebold *et al.* (2008), Bae and Kim (2011), and Abbriti *et al.* (2018) show that global slope factor is closely related to global business cycle. To examine the relationship between global level and slope factors and global inflation and global business cycle, we regard the first component of the PCA for four countries' inflation variables as the global inflation factor and the first component of the PCA for four countries business cycle variables as the global business cycle factor. The correlation between the extracted global level factor and the global inflation factor is 0.68 and that between the extracted global slope factor and the global business cycle factor is 0.12, implying that extracted global level factor is closely related to global inflation; however, the relationship between extracted global slope factor and global business cycle appears weak.[11]

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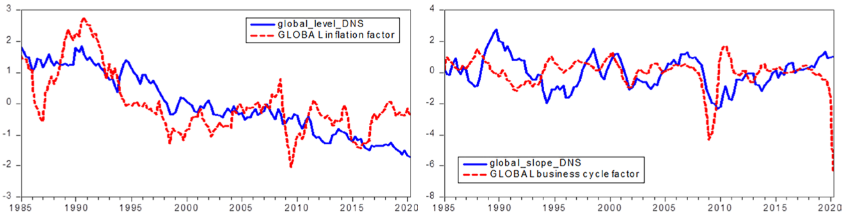
[11] Diebold *et al.* (2008) show that the correlation between their extracted global level factor and average G-7 inflation over 1985.09–2005.08 is 0.75, and



a. global level and macro factors(normalized)   b. global slope and macro factors(normalized)

FIGURE 3
GLOBAL YIELD FACTORS AND GLOBAL MACRO FACTORS

In <Figures 3.a and 3.b>, we plot the extracted global level and slope factors and the global inflation and the global business cycle factors.

Following Diebold *et al.* (2008), we consider two macro factors, namely, global inflation and global business cycle, and then estimate the dynamic relationship between global level and slope factors and global inflation and global business cycle. Table 4 shows the estimation results.

The global level factor is highly serially correlated. The estimated coefficient on global inflation is positive but not statistically significant in the global level factor dynamics, whereas the estimated coefficient on global business cycle is negative but not statistically significant. These results reassure that global level factor appears to be closely related to global inflation. All four countries' level factors load positively on global level factor. The country-specific level factors are highly persistent, except the UK. The persistence of the UK-specific level factor is much smaller than those of other three countries.

In the estimation results for the global and country slope factors, the global slope factor is highly serially correlated, and the estimated coefficients on global inflation and on global business cycle are positive. However, only the coefficient on global business cycle is statistically significant in the global slope factor dynamics. This result also confirms that global slope factor is closely related to global business cycle. All four country slope factors load positively on the global slope factor, and the Japanese slope loading is smaller than those of other countries. The

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the correlation between the extracted global slope factor and average G-7 GDP annual growth is 0.27.

TABLE 4

ESTIMATES OF THE GLOBAL YIELD-MACRO MODEL WITHOUT GLOBAL LIQUIDITY PARAMETERS

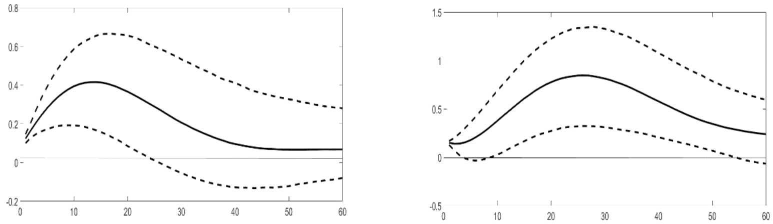
global level factor	
$L_t = \mathbf{0.9679}L_{t-1} + 0.0441f_{INF,t-1} - 0.0051f_{BUSS,t-1} + U_t^l$ (0.0237)*** (0.0351) (0.0680)	
country level factors	
$l_{US,t} = \mathbf{4.5932} + \mathbf{0.4752}L_t + \varepsilon_{US,t}^l$ (1.2293)*** (0.0444)***	$\varepsilon_{US,t}^l = \mathbf{0.8840}\varepsilon_{US,t-1}^l + \mathbf{0.3789}u_{US,t}^l$ (0.0538)*** (0.0203)***
$l_{GM,t} = \mathbf{3.4467} + \mathbf{0.4077}L_t + \varepsilon_{GM,t}^l$ (1.1185)*** (0.0302)***	$\varepsilon_{GM,t}^l = \mathbf{0.9669}\varepsilon_{GM,t-1}^l + \mathbf{0.1923}u_{GM,t}^l$ (0.0210)*** (0.0082)***
$l_{JP,t} = \mathbf{1.9070} + \mathbf{0.3131}L_t + \varepsilon_{JP,t}^l$ (0.8129)** (0.0301)***	$\varepsilon_{JP,t}^l = \mathbf{0.8430}\varepsilon_{JP,t-1}^l + \mathbf{0.3470}u_{JP,t}^l$ (0.0498)*** (0.0155)***
$l_{UK,t} = \mathbf{4.6319} + \mathbf{0.5104}L_t + \varepsilon_{UK,t}^l$ (1.2891)*** (0.0384)***	$\varepsilon_{UK,t}^l = \mathbf{0.2922}\varepsilon_{UK,t-1}^l + \mathbf{0.2803}u_{UK,t}^l$ (0.1543)* (0.0157)*
global slope factor	
$S_t = \mathbf{0.9062}S_{t-1} + 0.0174f_{INF,t-1} + \mathbf{0.3423}f_{BUSS,t-1} + U_t^S$ (0.0321)*** (0.0326) (0.0722)***	
country slope factors	
$S_{US,t} = \mathbf{-2.6449} + \mathbf{0.3858}S_t + \varepsilon_{US,t}^S$ (0.7845)*** (0.0543)***	$\varepsilon_{US,t}^S = \mathbf{0.9409}\varepsilon_{US,t-1}^S + \mathbf{0.5270}u_{US,t}^S$ (0.0313)*** (0.0430)***
$S_{GM,t} = \mathbf{-1.9010} + \mathbf{0.3222}S_t + \varepsilon_{GM,t}^S$ (0.7264)*** (0.0440)***	$\varepsilon_{GM,t}^S = \mathbf{0.9488}\varepsilon_{GM,t-1}^S + \mathbf{0.4391}u_{GM,t}^S$ (0.0261)*** (0.0285)***
$S_{JP,t} = \mathbf{-1.2298} + \mathbf{0.1339}S_t + \varepsilon_{JP,t}^S$ (0.3919)*** (0.0358)***	$\varepsilon_{JP,t}^S = \mathbf{0.9125}\varepsilon_{JP,t-1}^S + \mathbf{0.4081}u_{JP,t}^S$ (0.0329)*** (0.0206)***
$S_{UK,t} = \mathbf{-1.0085} + \mathbf{0.5904}S_t + \varepsilon_{UK,t}^S$ (0.5613)* (0.0619)***	$\varepsilon_{UK,t}^S = \mathbf{0.5753}\varepsilon_{UK,t-1}^S + \mathbf{0.4458}u_{UK,t}^S$ (0.2641)** (0.0692)***

Note: a. The table reports the parameters and standard errors in parenthesis for the global yield-only model, and the bold entries denote statistically significant estimates.

b. ***, **, * denote statistically significant at the 1%, 5%, and 10%, respectively.

country-specific slope factors are generally highly persistent, but the persistence of the UK-specific slope factor is smaller than those of other countries. Overall, the estimation results are similar to the case of the global yield only model, except that the persistence of the UK-specific slope factor is lower in the global yield-macro model than in the global yield only model.

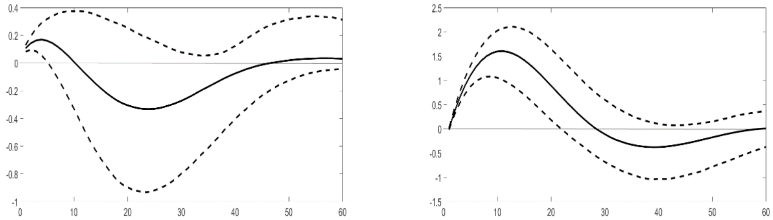
Based on the estimation results of the global yield-macro model with global inflation and global business cycle, we carry out the impulse responses of the global level factor



global inflation shock

global business cycle shock

responses of the global slope factor



global inflation shock

global business cycle shock

Figure 4
Responses Of The Global Level Factor

response analysis; Figure 4 shows the results[12].

The global level factor responds both to the shock of global inflation and that of global business cycle. That is, the positive shock to global inflation appears to have a positive impact on the global level factor due to the following: given that the level factor reflects the nominal long-term rate and the latter reflects the inflation expectation in the dynamic Nelson-Siegel factor model, the shock to global inflation is transmitted to the global level factor. This result is consistent with Ang and Piazessi (2003), Diebold *et al.* (2006), and Rudebusch and Wu (2008). In addition, the global level factor responds to the shock of global business cycle. Diebold *et al.* (2006) and Rudebusch and Wu (2008) show that

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[12] We employ Cholesky decomposition in the impulse response analysis, and the order of variables is same with Equation (10). For the robustness check, we have many different orders and find that the results are qualitatively similar to this paper.

the shock to global business cycle increases the US-level factor with significant lags. We interpret that the increase in the expected inflation as the result of business cycle expansion will have an impact on the long-term interest rate in the long run.

For the global slope factor, the shock to global business cycle appears to have an impact on the global slope factor, whereas the global slope factor scarcely responds to the shock of global inflation. Hamilton and Kim (2002) and Ang *et al.* (2006) state that by using the relationship between economic fluctuation and yield spread given that the central bank attempts to raise the short-term rate in the economic expansion to cool down the economy, yield spread reflects the business cycle state. That is, the slope factor is the difference between the short-and long-term interest rates, and the change in the short-term interest rate due to the change in economic status is reflected on the slope factor in the DNS model. This mechanism may work in the global factor context. The global economic expansion may result in the increase in overall interest rates, and the higher increase in the short-term rate relative to the long-term rate would increase the global slope factor. While Hordahl *et al.* (2006) and Bekaert *et al.* (2010) show that inflation factor has a significant impact on slope factor, we do not find such evidence.

Following Diebold *et al.* (2008), we conduct variance decompositions. We decompose the variation in the global level and slope factors into parts driven by global inflation variation and global business cycle variation. Table 5 shows the variance decompositions.

TABLE 5

VARIANCE DECOMPOSITION OF THE GLOBAL YIELD FACTORS (%)

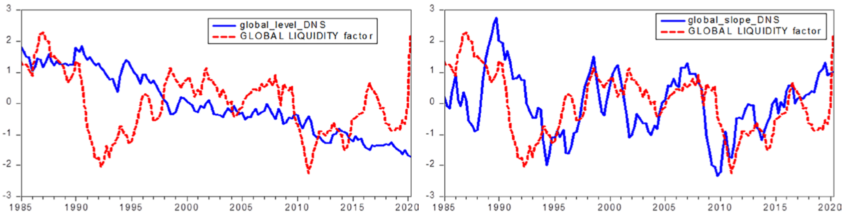
global level	horizon	inflation	business cycle	level
	4q	4.36	2.07	93.58
	8q	8.16	3.60	88.25
	12q	11.46	7.63	80.92
	20q	13.76	22.06	64.18
	40q	9.98	46.24	43.79
global slope	horizon	inflation	business cycle	slope
	4q	0.81	29.48	69.71
	8q	0.39	66.09	33.52
	12q	0.44	79.70	19.87
	20q	2.85	84.81	12.34
	40q	9.62	79.85	10.53

In the case of global level variation, variation in global inflation explains 14% fraction of the variation in global level factor only in the short run; whereas variation in global business cycle explains 45% fraction of the variation in global-level factor only in the long run. Global inflation appears to be a significant component to explain the global-level variation in the short run, whereas global business cycle does in the long run. In the case of global slope variation, the variation in global business cycle explains 30%–80% fraction of the variation in global slope factor, whereas the variation in global inflation scarcely plays a role in global slope variation. This result is consistent with Diebold and Li (2006), Diebold *et al.* (2006), and Diebold *et al.* (2008), where slope factor is closely related to yield spread, and yield curve slope is linked to business cycle (real activity).

D. Estimation results: Global yield model with inflation, business cycle, and liquidity macro factors

In this paper, we consider another global macroeconomic factor, which is global liquidity. Since the global financial crisis in 2008, substantial interest in global liquidity has occurred, and many studies have shown that global liquidity played an important role in the world macroeconomy. D'Agostino and Surico (2009) show that global liquidity estimated from the PCA of the M2 growths of G7 countries has more predictive power in forecasting US inflation than the US M2 growth. Belke *et al.* (2013) and Beckmann *et al.* (2014) confirm that the shock to global liquidity has a significant impact on the global price level. Belke *et al.* (2010) show that global liquidity has a long-term relationship with global price. Eickmeier *et al.* (2014) examine the effect of global liquidity on financial variables and find that the interest rates in advanced countries are largely explained by global liquidity. Kang *et al.* (2016) find that the effect of global liquidity on price level has increased since the global financial crisis in 2008.

Given the possibility of the role of global liquidity in the global interest rate dynamics, we consider not only global inflation and global business cycle but also global liquidity while attempting to incorporate these three macro factors into the global yield model. To examine the relationship between the extracted global level and slope factors and the global liquidity factor, we estimate the first component of the PCA for the four countries' credit-to-GDP ratios and broad money and regard



a. global level and liquidity factors(normalized) b. global slope and liquidity factors(normalized)

FIGURE 5

GLOBAL YIELD FACTORS AND GLOBAL LIQUIDITY

it as the global liquidity factor. The correlation between the extracted global level factor and the global liquidity factor is 0.28 and that between the extracted global slope factor and the global liquidity factor is 0.52, suggesting that extracted global factors are related to global liquidity. In Figures 5.a and 5.b, we plot the extracted global level and slope factors and the global liquidity factor. The global factors and the global liquidity factor appear to be correlated.

Following Diebold *et al.* (2008), we estimate the dynamic relationship between the global level and slope factors and three macro factors, namely, global inflation, global business cycle, and global liquidity. Table 6 shows the estimation results.

As before, the global level factor is highly serially correlated. The estimated coefficients on the global inflation and global liquidity are positive, but only the coefficient on global liquidity is statistically significant. The estimated coefficient on global business cycle is negative but not statistically significant. The interesting point to make is that only the coefficient on global liquidity factor is statistically significant; thus, the global level factor appears to be closely related to global liquidity. The dynamics of all four countries' level factors and country-specific level factors are quite similar to the estimation results of the global yield model with two macro factors, namely, global inflation and global business cycle. That is, all four countries' level factors load positively on the global-level factor, and the country-specific level factors are highly persistent, except the UK. These results imply that global liquidity factor plays an important role only in the global factor.

For estimation results of the global and country slope factors, the estimated coefficients on global inflation and global liquidity are positive but not statistically significant; whereas the coefficient on

TABLE 6

ESTIMATES OF THE GLOBAL YIELD-MACRO MODEL WITH GLOBAL LIQUIDITY PARAMETERS

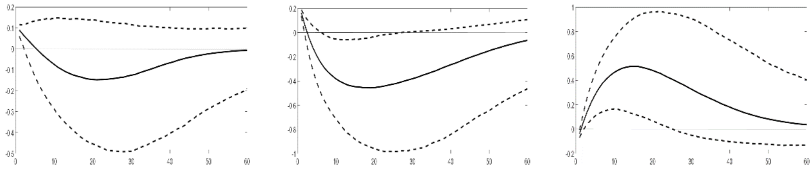
global level factor	
$L_t = \mathbf{0.9562}L_{t-1} + 0.0348f_{INF,t-1} - 0.0524f_{BUSS,t-1} + \mathbf{0.1040}f_{LIQ,t-1} + U_t^l$ (0.0196)*** (0.0606) (0.0455) (0.0481)**	
country level factors	
$l_{US,t} = \mathbf{4.2295} + \mathbf{0.4558}L_t + \varepsilon_{US,t}^l$ (1.4809)*** (0.0430)***	$\varepsilon_{US,t}^l = \mathbf{0.8868}\varepsilon_{US,t-1}^l + \mathbf{0.3786}u_{US,t}^l$ (0.0539)*** (0.0203)***
$l_{GM,t} = \mathbf{3.1246} + \mathbf{0.3923}L_t + \varepsilon_{GM,t}^l$ (1.3308)** (0.0287)***	$\varepsilon_{GM,t}^l = \mathbf{0.9677}\varepsilon_{GM,t-1}^l + \mathbf{0.1903}u_{GM,t}^l$ (0.0210)*** (0.0082)***
$l_{JP,t} = \mathbf{1.6638} + \mathbf{0.3989}L_t + \varepsilon_{JP,t}^l$ (0.9742)* (0.0287)***	$\varepsilon_{JP,t}^l = \mathbf{0.8408}\varepsilon_{JP,t-1}^l + \mathbf{0.3480}u_{JP,t}^l$ (0.0498)*** (0.0155)***
$l_{UK,t} = \mathbf{4.2483} + \mathbf{0.4858}L_t + \varepsilon_{UK,t}^l$ (1.5442)*** (0.0370)***	$\varepsilon_{UK,t}^l = \mathbf{0.2939}\varepsilon_{UK,t-1}^l + \mathbf{0.2829}u_{UK,t}^l$ (0.1550)* (0.0157)***
global slope factor	
$S_t = \mathbf{0.8825}S_{t-1} + 0.0294f_{INF,t-1} + \mathbf{0.3387}f_{BUSS,t-1} + 0.0302f_{LIQ,t-1} + U_t^S$ (0.0375)*** (0.0544) (0.0529)*** (0.0564)	
country slope factors	
$S_{US,t} = \mathbf{-2.5695} + \mathbf{0.3840}S_t + \varepsilon_{US,t}^S$ (0.7583)*** (0.0540)***	$\varepsilon_{US,t}^S = \mathbf{0.9396}\varepsilon_{US,t-1}^S + \mathbf{0.5303}u_{US,t}^S$ (0.0310)*** (0.0425)***
$S_{GM,t} = \mathbf{-1.8442} + \mathbf{0.3252}S_t + \varepsilon_{GM,t}^S$ (0.6980)*** (0.0438)***	$\varepsilon_{GM,t}^S = \mathbf{0.9495}\varepsilon_{GM,t-1}^S + \mathbf{0.4379}u_{GM,t}^S$ (0.0258)*** (0.0280)***
$S_{JP,t} = \mathbf{-1.2045} + \mathbf{0.1338}S_t + \varepsilon_{JP,t}^S$ (0.3837)*** (0.0358)***	$\varepsilon_{JP,t}^S = \mathbf{0.9122}\varepsilon_{JP,t-1}^S + \mathbf{0.4085}u_{JP,t}^S$ (0.0328)*** (0.0206)***
$S_{UK,t} = \mathbf{-0.8946} + \mathbf{0.5981}S_t + \varepsilon_{UK,t}^S$ (0.4780)* (0.0617)***	$\varepsilon_{UK,t}^S = \mathbf{0.4932}\varepsilon_{UK,t-1}^S + \mathbf{0.4311}u_{UK,t}^S$ (0.2507)** (0.0672)***

Note: a. The table reports the parameters and standard errors in parenthesis for the global yield-only model, and the bold entries denote statistically significant estimates.

b. ***, **, * denote statistically significant at the 1%, 5%, and 10%, respectively.

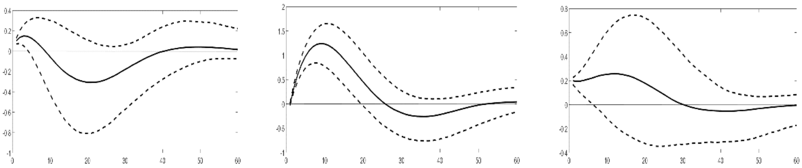
global business cycle is positive and statistically significant. This result indicates that only global business cycle factor plays an important role in the global slope factor, confirming that the slope factor is closely related to business cycle. Furthermore, the global slope factor is persistent. The dynamics of all four countries' slope factors and country-specific factors are very similar to the case of the global yield model with two macro factors. This result implies that global liquidity has little impact on the global and country slope factors.

responses of the global level factor



global inflation shock global business cycle shock global liquidity shock

responses of the global slope factor



global inflation shock global business cycle shock global liquidity shock

Figure 6

Responses of the global yield factors

inflation, whereas it does to the shock of global liquidity. Furthermore, the global level factor seems to respond to the shock to global business cycle only in the short run, and such an effect appears to disappear in the long run. As in the case of previous estimation results, the information on global inflation is reflected in global liquidity; thus, only global liquidity has a significant impact on global level factor. According to the Fisher equation, we conject that the expansion of global liquidity increases the inflation expectation and thus has an impact on the global level factor. In the impulse response analysis for global slope factor, global business cycle has a significant impact on the global slope factor. The global slope factor seems to respond to both shocks to global inflation and global liquidity in the short run, but the responses appear to be relatively small compared with business cycle shock and disappear after several quarters. We interpret that global liquidity does not play an important role in the global slope dynamics because global liquidity affects the overall interest rates of all maturities and thus has little impact on the slope of the yield curve. By contrast, global business cycle shock has a significant impact on global slope factor. This result is consistent with the predictive power of yield spread for business cycle as in Hamilton and Kim (2002).

TABLE 7

VARIANCE DECOMPOSITION OF THE GLOBAL YIELD FACTORS

global level	horizon	inflation	business cycle	global liquidity	level
	4q	0.74	1.22	1.31	96.73
	8q	0.41	6.38	7.12	86.08
	12q	0.35	13.64	14.28	71.73
	20q	0.67	24.87	25.12	49.34
	40q	1.65	36.51	34.24	27.60
global slope	horizon	inflation	business cycle	global liquidity	slope
	4q	0.61	26.94	3.98	68.47
	8q	0.30	61.95	3.35	34.30
	12q	0.98	74.62	3.11	21.28
	20q	5.40	77.33	3.10	14.18
	40q	11.42	73.04	3.10	12.44

Finally, we conduct variance decompositions of global yield factors. Table 7 shows the variance decompositions.

In the case of global level variation, variation in global inflation does not explain the variation in global level factor; whereas variation in global liquidity explains variation in global level factor up to 34% fraction. The variation in the global business cycle still explains 36% fraction of the variation in global level factor in the long run. As before, global liquidity appears to not only have global inflation but also other information for global slope factor. In addition, global business cycle is useful for explaining variation in global slope factor in the long run. In the case of global slope variation, the variation in global business cycle explains 27%–73% fraction of the variation in global slope factor, whereas the variations in global inflation and in global liquidity scarcely play a role in global slope variation. This result confirms that slope factor is closely related to yield spread, and yield curve slope is linked to business cycle (real activity) as suggested in the existing literature. In sum, global liquidity plays an important role in explaining the dynamics of global level factor but not global slope factor.

IV. Concluding remarks

Recently, explaining the dynamics of interest rates was attempted in the Macro-Finance model framework and in the global context. That is, common global yield factors exist and are operative on the nature of dynamic cross-country bond yield interactions, and macroeconomic factors play an important role in explaining global yield dynamics. In particular, global inflation and global business cycle have been emphasized as key macro factors that play an important role in the global-level and slope factors.

As the deepening of financial integration and cross-border lending has increased capital inflow and the financial dependence between economies, global liquidity has become a key focus of financial stability and goods and assets price inflation. This phenomenon reflects a perception that global liquidity is an important driver of capital flows, global asset price dynamics, and inflation. Thus, global liquidity may play an important role in explaining the cross-border interest dynamics. This paper tackles the question of whether global liquidity has an impact on global yield dynamics. In the empirical study, we consider the dynamic Nelson-Siegel model of Diebold *et al.* (2008) with three macro factors: global inflation, global business cycle, and global liquidity. We consider the yield of four advanced economies—the U.S., the U.K., Germany, and Japan—from the first quarter in 1985 to the second quarter in 2020.

We find that global liquidity plays an important role in the global level factor but not in the global slope factor. In particular, when we incorporate global liquidity into the dynamic Nelson-Siegel factor model, global inflation is no longer a key factor in explaining the global level factor. We interpret that global liquidity not only has the information on global commodity inflation but also on global asset price inflation and expected future inflation. However, global liquidity does not seem to play an important role in global slope factor, indicating that only global business cycle is linked to global slope factor as shown in the existing literature. Therefore, global liquidity is economically important because it is not only a major determinant of goods price inflation but is also an important macro factor that has an impact on global yield curve dynamics.

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Appendix 1

Cumulated Variance Shares Explained By Principal Components

principal component	global inflation	global business cycle	global liquidity
1st	54.27%	70.78%	45.55%
2nd	69.04%	82.45%	62.56%
3rd	78.67%	89.00%	76.53%
4th	87.28%	94.06%	85.95%
5th	93.51%	96.25%	91.00%
6th	96.40%	87.68%	95.53%
7th	98.47%	98.99%	98.87%
8th	100%	100%	100%

Appendix 2

VAR Estimates For Yield-Macro Model Without Global Liquidity

	$f_{INF,t-1}$	$f_{BUSS,t-1}$	adj-R^2
$f_{INF,t}$	0.949*** (0.024)	0.230*** (0.058)	0.919
$f_{BUSS,t}$	-0.038* (0.024)	0.961*** (0.058)	0.668

Note: a. The entries in the parentheses are OLS standard errors.
b. ***, ** and * denote statistically significant at the 1%, 5%, and 10% levels, respectively.

Appendix 3

VAR Estimates For Yield-Macro Model With Global Liquidity

	$f_{INF,t-1}$	$f_{BUSS,t-1}$	$f_{LIQ,t-1}$	adj-R^2
$f_{INF,t}$	0.948*** (0.024)	0.218*** (0.058)	0.054* (0.031)	0.920
$f_{BUSS,t}$	−0.038 (0.024)	0.958*** (0.058)	0.014 (0.041)	0.666
$f_{LIQ,t}$	−0.018 (0.024)	−0.057 (0.058)	0.948*** (0.031)	0.873

Note: a. The entries in the parentheses are OLS standard errors.
b. ***, ** and * denote statistically significant at the 1%, 5%, and 10% levels, respectively.

References

Abbritti, M., Dell'Erba, S., Moreno, A., and Sola, S. "Global factors in the term structure of interest rates." *International Journal of Central Banking* 14(No. 2 2018): 301-339.

Andersen, T. G., and Lund, J. *Stochastic volatility and mean drift in the short term interest rate diffusion: Source of steepness, level and curvature in the yield curve*. Working paper 214, Department of Finance, Kellogg School, Northwestern University, 1997.

Ang, A., and Piazzesi, M. "A no-arbitrage vector autoregression of term structure dynamics with macroeconomic and latent variables." *Journal of Monetary economics* 50(No. 4 2003): 745-787.

Ang, A., Piazzesi, M., and Wei, M. "What does the yield curve tell us about GDP growth?" *Journal of econometrics* 131(No. 1 2006): 359-403.

Bae, B. Y., and Kim, D. H. "Global and regional yield curve dynamics and interactions: The case of some Asian countries." *International Economic Journal* 25(No. 4 2011): 717-738.

Beckmann, J., Belke, A., and Czudaj, R. "Does global liquidity drive commodity prices?" *Journal of Banking & Finance* 48(2014): 224-234.

Bekaert, G., Cho, S., and Moreno, A. "New Keynesian macroeconomics and the term structure." *Journal of Money, Credit and Banking* 42(No. 1 2010): 33-62.

Belke, A., Orth, W., and Setzer, R. "Liquidity and the dynamic pattern of asset price adjustment: A global view," *Journal of Banking & Finance* 34(No. 8 2010): 1933-1945.

Belke, A., Bordon, I. G., and Volz, U."Effects of global liquidity on commodity and food prices." *World Development* 44(2013): 31-43.

Bruno, V., and Shin, H. S. "Capital flows and the risk-taking channel of monetary policy." *Journal of Monetary Economics* 71(2015): 119-132.

Campbell, J. Y., Sunderam, A., and Viceira, L. M. *Inflation bets or deflation hedges? The changing risks of nominal bonds*. Working paper, MIMEO Harvard University, 2016.

Chen, S., Liu, P., Maechler, A. M., Marsh, C., Saksonovs, S., and Shin, H. S. *Exploring the dynamics of global liquidity*. BIS, 2012.

Ciccarelli, M., and Mojon, B. "Global inflation," *The Review of Economics and Statistics* 92(No. 3 2012): 524-535.

Chung, K., Lee, J. E., Loukoianova, E., Park, H., and Shin, H. S. "Global liquidity through the lens of monetary aggregates." *Economic Policy* 30(No. 82 2015): 231-290.

D'Agostino, A., and Surico, P. "Does global liquidity help to forecast US inflation?" *Journal of Money, Credit and Banking* 41(No. 2-3 2009): 479-489.

Dewachter, H., and Lyrio, M. "Macro factors and the term structure of interest rates," *Journal of Money, Credit and Banking*(2006): 119-140.

Dewachter, H., Iania, L., and Lyrio, M. "Information in the yield curve: A Macro-Finance approach," *Journal of Applied Econometrics* 29(No. 1 2014): 42-64.

Diebold, F. X., and Li, C. "Forecasting the term structure of government bond yields." *Journal of econometrics* 130(No. 2 2006): 337-364.

Diebold, F. X., Piazzesi, M., and Rudebusch, G. D. "Modeling bond yields in finance and macroeconomics." *American Economic Review* 95(No. 2 2005): 415-420.

Diebold, F. X., Rudebusch, G. D., and Aruoba, S. B. "The macroeconomy and the yield curve: a dynamic latent factor approach." *Journal of econometrics* 131(No. 1 2006): 309-338.

Diebold, F. X., Li, C., and Yue, V. Z. "Global yield curve dynamics and interactions: a dynamic Nelson--Siegel approach." *Journal of Econometrics* 146(No. 2 2008): 351-363.

Domanski, D., Fender, I., and McGuire, P. *Assessing global liquidity*. BIS Quarterly Review, December, 2011.

Eickmeier, S., Gambacorta, L., and Hofmann, B. "Understanding global liquidity." *European Economic Review* 68(2014): 1-18.

Giese, J. V., and Tuxen, C. K. *Global liquidity and asset prices in a cointegrated VAR*. Nuffield College, University of Oxford, and Department of Economics, Copenhagen University, 1-28, 2007.

Hordahl, P., Tristani, O., and Vestin, D. "A joint econometric model of macroeconomic and term-structure dynamics." *Journal of Econometrics* 131(No. 1 2006): 405-444.

Hamilton, J. D., and Kim, D. H. "A re-examination of the predictability of the yield spread for real economic activity." *Journal of Money, Credit, and Banking* 34(No. 2 2002): 340-360.

Kim, Y. J. "Global or Country Business Cycles: Developed versus Developing Countries," *Seoul Journal of Economics* 34(No. 1 2021): 81-98.

Landau, J. P. *Global liquidity-concept, measurement and policy implications*. CGFS Papers, 45, 2011.

Mumtaz, H., Simonelli, S., and Surico, P. "International comovements, business cycle and inflation: A historical perspective." *Review of Economic Dynamics* 14(No. 1 2011): 176-198.

Kang, H., Yu, B. K., and Yu, J. "Global liquidity and commodity prices." *Review of International Economics* 24(No. 1 2016): 20-36.

Kim, C. J., and Nelson, C. R. *State-space models with regime switching: classical and Gibbs-sampling approaches with applications*. MIT Press Books, 1999.

Kose, M. A., Otrok, C., and Whiteman, C. H. "International business cycles: World, region, and country-specific factors." *The American Economic Review* 93(No. 4 2003): 1216-1239.

Paccagnini, A. "The macroeconomic determinants of the US term structure during the Great Moderation." *Economic Modelling* 52(2006): 216-225.

Qadan, M., and Yagil, J. "International co-movements of real and financial economic variables." *Applied Economics* 47(No. 31 2015): 3347-3366.

Rudebusch, G. D. *Macro-finance models of interest rates and the economy. The Manchester School*, Supplement, 25-52, 2015.

Rudebusch, G. D., and Wu, T. "Accounting for a Shift in Term Structure Behavior with No-Arbitrage and Macro-Finance Models." *Journal of Money, Credit and Banking*, 39(No. 2-3 2007): 395-422.

Rudebusch, G. D., and Wu, T. "A Macro-Finance Model of the Term Structure, Monetary Policy and the Economy." *The Economic Journal* 118(No. 530 2008): 906-926.

Rüffer, R., and Stracca, L.*What is global excess liquidity, and does it matter?* ECB Working Paper No. 696, 2006.

Sousa, J., and Zaghini, A. "Monetary policy shocks in the euro area and global liquidity spillovers." *International journal of finance & Economics* 13(No. 3 2008): 205-218.

Wright, J. H. "Term premia and inflation uncertainty: Empirical evidence from an international panel dataset." *The American Economic Review* 101(No. 4 2011): 1514-1534.