Internet Appendices for
"Global Risk Aversion and International Return Comovements"

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September 9, 2019

In this file, I provide additional tables and figures to supplement the main results.

I. Additional tables for Section 2, the empirical model:

II. Additional tables for Section 3, the economic determinants:

III. Additional tables for Section 4, the dynamic factor model:

IV. Additional figures:

V Solving an International Asset Pricing Model

In the main text (Section 3), for simplicity, I assume that there exists a global investor who prices both U.S. and foreign country assets (equities and Treasury bonds), and thus the asset prices are solved from the perspective of this global investor. The advantage of that parsimonious framework is to motivate a global dynamic factor model examined in Section 4.

In this appendix section, I acknowledge the exchange rates dynamics and different real pricing kernel of each country. For each country, its domestic investor prices domestic assets where (1) the domestic macro environment and investor risk aversion receive global state variable exposures, and (2) the domestic investor's pricing kernel reflects partial integration. Section V.1 introduces the U.S. state variables and real pricing kernel and solves the U.S. asset prices; Section V.2 discusses the individual country real pricing kernels and state variables as well as model solutions.

The main take-away is that a global dynamic factor model still holds.

V.1 The U.S. Asset Market

V.1.1 U.S. State Variable Dynamics

V.1.1.a Matrix representation In a matrix representation, the U.S. state vector at time t is denoted as $\boldsymbol{X_{t+1}}$ (11 × 1),

$$\begin{bmatrix} \theta_{t+1} & \text{Industrial production growth} \\ \theta u_{t+1} & \text{Real upside uncertainty} \\ \theta d_{t+1} & \text{Real downside uncertainty} \\ \pi_{t+1} & \text{Inflation} \\ \pi u_{t+1} & \text{Nominal upside uncertainty} \\ \pi d_{t+1} & \text{Nominal downside uncertainty} \\ x_{t+1} & \text{Real short rate} \\ xu_{t+1} & \text{Real short rate upside uncertainty} \\ xd_{t+1} & \text{Real short rate downside uncertainty} \\ g_{t+1} & \text{Dividend growth} \\ q_{t+1} & \text{Global risk aversion} \end{bmatrix},$$

which follows this general dynamics:

$$\boldsymbol{X_{t+1}} = \boldsymbol{\xi_{X,t}} + Jensen's\,(\boldsymbol{\delta_X}, \boldsymbol{S_t}) + \boldsymbol{\delta_X}\boldsymbol{\omega_{t+1}}, \tag{A1}$$

$$\boldsymbol{\omega_{t+1}} \sim \Gamma(\boldsymbol{S_t}, \boldsymbol{1}) - \boldsymbol{S_t}, \tag{A2}$$

where $\boldsymbol{\xi_{X,t}}$ (11 × 1) denotes the conditional mean vector; $\boldsymbol{\omega_{t+1}}$ (8 × 1) denotes the global state variable shock matrix $\begin{bmatrix}\omega_{\theta u,t+1} & \omega_{\theta d,t+1} & \omega_{\pi u,t+1} & \omega_{\pi d,t+1} & \omega_{xu,t+1} & \omega_{xd,t+1} & \omega_{g,t+1} & \omega_{q,t+1}\end{bmatrix}'$ where the shocks are mutually independent; $\boldsymbol{\delta_X}$ (11 × 8) denotes the constant coefficient matrix to the state variable shocks $\boldsymbol{\omega_{t+1}}$; $\boldsymbol{S_t}$ (8 × 1) is the vector of the shock shape parameters $\begin{bmatrix}\theta u_t & \theta d_t & \pi u_t & \pi d_t & xu_t & xd_t & v & q_t\end{bmatrix}'$; $Jensen's\,(\boldsymbol{\delta_X}, \boldsymbol{S_t})$ denotes the Jensen's inequality term from Gamma distributions; $\Gamma(s, 1)$ denotes the Gamma random variable with a shape parameter s and a scale parameter 1.

The six uncertainty state variables and their shocks are denoted as,

$$\boldsymbol{U_t} = \begin{bmatrix}\theta u_t & \theta d_t & \pi u_t & \pi d_t & xu_t & xd_t\end{bmatrix}',$$

$$\boldsymbol{\omega_{U,t+1}} = \begin{bmatrix}\omega_{\theta u,t+1} & \omega_{\theta d,t+1} & \omega_{\pi u,t+1} & \omega_{\pi d,t+1} & \omega_{xu,t+1} & \omega_{xd,t+1}\end{bmatrix}'.$$

V.1.1.b Output growth and uncertainties I follow Bekaert, Engstrom, and Xu (2019) to model industrial production growth innovation with two centered independent gamma shocks where each shock has a time-varying shape parameter that governs the higher moments of the shock. I name the shape parameter that governs the right-tail (left-tail) skewness the real upside (downside) uncertainty, θu (θd).[33] Formally, θ_{t+1} has the following process,

$$\theta_{t+1} = \overline{\theta} + \rho_{\theta\theta}(\theta_t - \overline{\theta}) + \rho_{\theta\theta u}(\theta u_t - \overline{\theta u}) + \rho_{\theta\theta d}(\theta d_t - \overline{\theta d}) + u^{\theta}_{t+1}, \tag{A3}$$

where the growth shock is decomposed into two independent shocks,

$$u^{\theta}_{t+1} = \delta_{\theta\theta u}\omega_{\theta u,t+1} - \delta_{\theta\theta d}\omega_{\theta d,t+1}. \tag{A4}$$

[33]Note that Bekaert, Engstrom, and Xu (2019) name them "good" and "bad" uncertainties to assign economic meanings of real uncertainties, whereas my notation here is more general and consistent as, for example, inflation upside uncertainty (later) is not typically considered as "good" uncertainty.

The shocks follow centered Gamma distributions with time-varying shape parameters,

$$\omega_{\theta u,t+1} \sim \widetilde{\Gamma}(\theta u_t, 1) \tag{A5}$$
$$\omega_{\theta d,t+1} \sim \widetilde{\Gamma}(\theta d_t, 1), \tag{A6}$$

where $\widetilde{\Gamma}(y, 1)$ denotes a centered Gamma-distributed random variable with shape parameter y and a unit scale parameter. The shape factors, θu_t and θd_t, follow autoregressive processes,

$$\theta u_{t+1} = \overline{\theta u} + \rho_{\theta u}(\theta u_t - \overline{\theta u}) + \delta_{\theta u}\omega_{\theta u,t+1} \tag{A7}$$
$$\theta d_{t+1} = \overline{\theta d} + \rho_{\theta d}(\theta d_t - \overline{\theta d}) + \delta_{\theta d}\omega_{\theta d,t+1}, \tag{A8}$$

where ρ_y denotes the autoregressive term of process y_{t+1}, δ_y the sensitivity to $\omega_{y,t+1}$, and $\overline{y}$ the constant long-run mean. Given that Gamma distributions are right-skewed by design, the growth shock with a negative loading on $\omega_{\theta d,t+1}$ models the left-tail events; hence, $\omega_{\theta d,t+1}$ is interpreted as the downside uncertainty shocks, and θd_t the real downside uncertainty.
State variables: $\{\theta, \theta u, \theta d\}$.
State variable shocks: $\{\omega_{\theta u}, \omega_{\theta d}\}$.

V.1.1.c Inflation and uncertainties

Inflation process receives contemporaneous shocks from the real side. Denote π_{t+1} as the change in the log consumer price index for all urban consumers, πu_t the nominal upside uncertainty and πd_t the nominal downside uncertainty. The inflation system follows this reduced-form dynamics,

$$\begin{aligned}\pi_{t+1} = \overline{\pi} + \rho_{\pi\theta}(\theta_t - \overline{\theta}) + \rho_{\pi\theta u}(\theta u_t - \overline{\theta u}) + \rho_{\pi\theta d}(\theta d_t - \overline{\theta d}) \\ + \rho_{\pi\pi}(\pi_t - \overline{\pi}) + \rho_{\pi\pi u}(\pi u_t - \overline{\pi u}) + \rho_{\pi\pi d}(\pi d_t - \overline{\pi d}) + u^{\pi}_{t+1},\end{aligned} \tag{A9}$$

where the inflation disturbance is sensitive to the two real uncertainty shocks, and the residual is decomposed into two nominal uncertainty shocks that are mutually independent of one another,

$$u^{\pi}_{t+1} = (\delta_{\pi\theta u}\omega_{\theta u,t+1} + \delta_{\pi\theta d}\omega_{\theta d,t+1}) + (\delta_{\pi\pi u}\omega_{\pi u,t+1} - \delta_{\pi\pi d}\omega_{\pi d,t+1}). \tag{A10}$$

The shocks follow centered Gamma distributions with time-varying shape parameters,

$$\omega_{\pi u,t+1} \sim \widetilde{\Gamma}(\pi u_t, 1) \tag{A11}$$
$$\omega_{\pi d,t+1} \sim \widetilde{\Gamma}(\pi d_t, 1), \tag{A12}$$
$$\pi u_{t+1} = \overline{\pi u} + \rho_{\pi u}(\pi u_t - \overline{\pi u}) + \delta_{\pi u}\omega_{\pi u,t+1} \tag{A13}$$
$$\pi d_{t+1} = \overline{\pi d} + \rho_{\pi d}(\pi d_t - \overline{\pi d}) + \delta_{\pi d}\omega_{\pi d,t+1}. \tag{A14}$$

Importantly, the theoretical structural representation of the inflation dynamics above is,

$$\pi_{t+1} = \xi_{\pi,t} + [\boldsymbol{\delta_\pi} - \ln(\mathbf{1} + \boldsymbol{\delta_\pi})]\boldsymbol{S_t} + \boldsymbol{\delta_\pi}\boldsymbol{\omega_{t+1}}, \tag{A15}$$

where $\boldsymbol{\delta_\pi} = \begin{bmatrix}\delta_{\pi\theta u} & \delta_{\pi\theta d} & \delta_{\pi\pi u} & -\delta_{\pi\pi d} & 0 & 0 & 0 & 0\end{bmatrix}$ so that the relevant shocks are $\omega_{\theta u,t+1}$, $\omega_{\theta d,t+1}$, $\omega_{\pi u,t+1}$, and $\omega_{\pi d,t+1}$. The signs of the the innovation loadings on the two real uncertainty shocks, $\omega_{\theta u,t+1}$ and $\omega_{\theta d,t+1}$, are not restricted in the model, whereas $\delta_{\pi\pi u}$ and $\delta_{\pi\pi d}$ are assumed to be positive.
State variables: $\{\pi, \pi u, \pi d\}$.
State variable shocks: $\{\omega_{\pi u}, \omega_{\pi d}\}$.

V.1.1.d Risk aversion Denote q_t as the time-varying risk aversion variable,[34]

$$q_{t+1} = \overline{q} + \rho_{q\theta}(\theta_t - \overline{\theta}) + \rho_{q\theta u}(\theta u_t - \overline{\theta u}) + \rho_{q\theta d}(\theta d_t - \overline{\theta d}) + \rho_{q\pi}(\pi_t - \overline{\pi}) + \rho_{q\pi u}(\pi u_t - \overline{\pi u}) + \rho_{q\pi d}(\pi d_t - \overline{\pi d}) + \rho_{qq}(q_t - \overline{q}) + u^q_{t+1}, \tag{A16}$$

where the risk aversion shock is sensitive to the real and nominal uncertainty shocks, the short rate shock and a risk aversion-specific heteroskedastic shock,

$$u^q_{t+1} = (\delta_{q\theta u}\omega_{\theta u,t+1} + \delta_{q\theta d}\omega_{\theta d,t+1}) + (\delta_{q\pi u}\omega_{\pi u,t+1} + \delta_{q\pi d}\omega_{\pi d,t+1}) + \delta_{qq}\omega_{q,t+1}, \tag{A17}$$

where the risk aversion-specific shock follows a centered heteroskedastic Gamma distribution,

$$\omega_{q,t+1} \sim \widetilde{\Gamma}(q_t, 1). \tag{A18}$$

State variables: $\{q\}$.
State variable shocks: $\{\omega_q\}$.

V.1.1.e Real short rate and uncertainties Denote x_t as the latent real short rate,

$$x_{t+1} = \overline{x} + \rho_{x\theta}(\theta_t - \overline{\theta}) + \rho_{x\theta u}(\theta u_t - \overline{\theta u}) + \rho_{x\theta d}(\theta d_t - \overline{\theta d}) + \rho_{x\pi}(\pi_t - \overline{\pi}) + \rho_{x\pi u}(\pi u_t - \overline{\pi u}) + \rho_{x\pi d}(\pi d_t - \overline{\pi d}) + \rho_{xx}(x_t - \overline{x}) + \rho_{xxu}(xu_t - \overline{xu}) + \rho_{xxd}(xd_t - \overline{xd}) + \rho_{xq}(q_t - \overline{q}) + u^x_{t+1}, \tag{A19}$$

where the short rate shock is sensitive to the real and nominal uncertainty shocks as well as a short rate-specific homoskedastic shock,

$$u^x_{t+1} = (\delta_{x\theta u}\omega_{\theta u,t+1} + \delta_{x\theta d}\omega_{\theta d,t+1}) + (\delta_{x\pi u}\omega_{\pi u,t+1} + \delta_{x\pi d}\omega_{\pi d,t+1}) + \delta_{xq}\omega_{q,t+1} + \delta_{xxu}\omega_{xu,t+1} - \delta_{xxd}\omega_{xd,t+1}, \tag{A20}$$

where the (exogenous) short rate shocks follow centered Gamma distributions with time-varying shape parameters,

$$\omega_{xu,t+1} \sim \widetilde{\Gamma}(xu_t, 1), xu_{t+1} = \overline{xu} + \rho_{xu}(xu_t - \overline{xu}) + \delta_{xu}\omega_{xu,t+1}, \tag{A21}$$

$$\omega_{xd,t+1} \sim \widetilde{\Gamma}(xd_t, 1), xd_{t+1} = \overline{xd} + \rho_{xd}(xd_t - \overline{xd}) + \delta_{xd}\omega_{xd,t+1}. \tag{A22}$$

State variables: $\{x, xu, xd\}$.
State variable shocks: $\{\omega_{xu}, \omega_{xd}\}$.

V.1.1.f Real dividend growth Denote g_t as the change in log real dividend per share,

$$g_{t+1} = \overline{g} + \rho_{g\theta}(\theta_t - \overline{\theta}) + \rho_{g\theta u}(\theta u_t - \overline{\theta u}) + \rho_{g\theta d}(\theta d_t - \overline{\theta d}) + \rho_{gg}(g_t - \overline{g}) + u^g_{t+1}, \tag{A23}$$

where the dividend growth shock is sensitive to the real and nominal uncertainty shocks as well as a dividend-specific homoskedastic shock,

$$u^g_{t+1} = (\delta_{g\theta u}\omega_{\theta u,t+1} + \delta_{g\theta d}\omega_{\theta d,t+1}) + \delta_{gg}\omega_{g,t+1}, \tag{A24}$$

where the sign of δ_{gg} is not restricted, and the dividend-specific shock is assumed to follow a homoskedastic Gamma distribution,

$$\omega_{g,t+1} \sim \widetilde{\Gamma}(v, 1). \tag{A25}$$

[34] It is a risk aversion variable, because the exact definition is risk aversion (motivated form a HARA utility is $\gamma \exp(q_t)$).

Importantly, the theoretical structural representation of the real growth dynamics above is,

$$g_{t+1} = \xi_{g,t} + [\boldsymbol{\delta_g} + \ln(\mathbf{1} - \boldsymbol{\delta_g})]\boldsymbol{S_t} + \boldsymbol{\delta_g}\boldsymbol{\omega_{t+1}}, \tag{A26}$$

where $\boldsymbol{\delta_g} = \begin{bmatrix}\delta_{g\theta u} & \delta_{g\theta d} & 0 & 0 & 0 & 0 & \delta_{gg} & 0\end{bmatrix}$ so that the relevant shocks are $\omega_{\theta u,t+1}$, $\omega_{\theta d,t+1}$, and $\omega_{g,t+1}$.
State variables: $\{g\}$.
State variable shocks: $\{\omega_g\}$.

V.1.2 U.S. Real Pricing Kernel

I specify the (minus) logarithm of the real global pricing kernel to be affine to the global state variable levels and shocks,

$$-m_{t+1} \quad = \quad x_t + [\boldsymbol{\delta_m} - \ln(\mathbf{1} + \boldsymbol{\delta_m})]\,\boldsymbol{S_t} + \boldsymbol{\delta_m}\boldsymbol{\omega_{t+1}}, \tag{A27}$$

where the drift x_t is the real short rate, $\boldsymbol{\delta_m}$ (1×8) prices of risks, $\boldsymbol{\omega_{t+1}}$ (8×1) the state variable shock matrix defined earlier, and $[\boldsymbol{\delta_m} - \ln(1 + \boldsymbol{\delta_m})]\,\boldsymbol{S_t}$ the Jensen's inequality term given the Gamma distributional assumptions.

The real global pricing kernel is spanned by five global shocks: the real upside and downside uncertainty shocks ($\omega_{\theta u}$ and $\omega_{\theta d}$), the inflation upside and downside uncertainty shocks ($\omega_{\pi u}$ and $\omega_{\pi d}$), and the risk aversion shock (ω_q). First, the two real-side uncertainty shock and the risk aversion shock span the pricing kernel, which can be motivated in Campbell and Cochrane (1999) and Bekaert, Engstrom, and Xu (2019). Second, the two inflation uncertainty shocks span the real pricing kernel, which is to induce the inflation risk premium.

V.1.3 U.S. Asset Prices and Risk Premiums

V.1.3.a Nominal Treasury Bonds The real global short rate ($y_{t,1} = -\ln\{[E_t[\exp(m_{t+1})]\}$) and the nominal global short rate ($\widetilde{y}_{t,1} = -\ln\{[E_t[\exp(m_{t+1} - \pi_{t+1})]\}$) are solved in closed forms,

$$y_{t,1} = x_t, \tag{A28}$$

$$\widetilde{y}_{t,1} = x_t + \underbrace{\xi_{\pi,t} + \ln\left[(\mathbf{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ (\mathbf{1} + \boldsymbol{\delta_m})^{\circ -1} \circ (\mathbf{1} + \boldsymbol{\delta_\pi})^{\circ -1}\right]\boldsymbol{S_t}}_{\text{inflation compensation}}, \tag{A29}$$

[35] where "ln(.)" is the element-wise logarithm operator, "$\circ$" the Hadamard product of two identically sized matrices (or element-by-element matrix multiplication), and "$(.)^{\circ -1}$" the Hadamard inverse. The three components in nominal short rate are the real short rate (x_t), the expected inflation rate ($\xi_{\pi,t}$), and the inflation risk premium to compensate investors for bearing the inflation risk associated with the nominal bonds. It is noteworthy that the linear approximation of the inflation risk premium, $\ln\left[(\mathbf{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ (\mathbf{1} + \boldsymbol{\delta_m})^{\circ -1} \circ (\mathbf{1} + \boldsymbol{\delta_\pi})^{\circ -1}\right]$, is $-(\boldsymbol{\delta_m} \circ \boldsymbol{\delta_\pi})\,\boldsymbol{S_t}$, or $Cov_t(m_{t+1}, \pi_{t+1})$ as derived in the Gaussian-augmented nominal term structure literature (see, e.g., Campbell, Sunderam, and Viceira, 2017).

The price of the n-period zero-coupon nominal bond ($\widetilde{P}^b_{t,n}$) can be then solved recursively in exact closed forms, and is an exponential affine function of a set of time-varying state variables.

$$\widetilde{P}^b_{t,n} = E_t\left[\exp\left(\widetilde{p}^b_{t+1,n-1} + m_{t+1} - \pi_{t+1}\right)\right] \tag{A30}$$

$$= E_t\left[\exp\left(x_{t+1} + \xi_{\pi,t+1} + \ln\left[(\mathbf{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ (\mathbf{1} + \boldsymbol{\delta_m})^{\circ -1} \circ (\mathbf{1} + \boldsymbol{\delta_\pi})^{\circ -1}\right]\boldsymbol{S_{t+1}} + m_{t+1} - \pi_{t+1}\right)\right] \tag{A31}$$

[35] In this paper, $\widetilde{(.)}$ denotes nominal variables.

$$= \exp\left(\boldsymbol{A_{0,n}} + \boldsymbol{A_{1,n}X_t}\right), \tag{A32}$$

where $A_{0,n}, \boldsymbol{A_{1,n}}$ are constant scalars or matrices.

The log return of the global nominal n-period zero-coupon bonds from t to $t+1$ can be expressed as follows,

$$\widetilde{r}^b_{t+1,n} \equiv \ln\left(\frac{\widetilde{P}^b_{t+1,n-1}}{\widetilde{P}^b_{t,n}}\right),$$

$$= \Omega^b_{0,n} + \boldsymbol{\Omega^b_{1,n}X_t} + \boldsymbol{\Omega^b_{2,n}\omega_{t+1}} + \left[\boldsymbol{\Omega^b_{2,n}} + \ln\left(1 - \boldsymbol{\Omega^b_{2,n}}\right)\boldsymbol{S_t}\right] + \epsilon^b_{t+1,n}, \tag{A33}$$

where $\epsilon^b_{t+1,n} \sim N(0, \sigma^2_b)$ is a homoskedastic Gaussian shock to potentially capture approximation error.

V.1.3.b Bond Risk Premium Given the no-arbitrage condition, $E_t[\exp(\widetilde{m}_{t+1} + \widetilde{r}^b_{t+1,n})] = 1$, the global bond risk premium (ignoring the Jensen's inequality terms) has a closed-form solution,

$$E_t[\widetilde{r}^b_{t+1,n}] - \widetilde{y}_{t,1} + \frac{1}{2}\sigma^2_b = \ln\left[(1 + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi} - \boldsymbol{\Omega^b_{2,n}}) \circ (1 + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1} \circ (1 - \boldsymbol{\Omega^b_{2,n}})^{\circ -1}\right]\boldsymbol{S_t}, \tag{A34}$$

[36] which in a quadratic Gaussian approximation has the following expression,

$$\approx \left[(\boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ \boldsymbol{\Omega^b_{2,n}}\right]\boldsymbol{S_t} = -Cov_t(\widetilde{m}_{t+1}, \widetilde{r}^b_{t+1,n}). \tag{A35}$$

[37] where $\boldsymbol{\delta_m}$ is the SDF loading on the four global uncertainty shocks subject to the time-varying global risk aversion as discussed in Section V.1.2, and $\boldsymbol{\delta_\pi}$ is the inflation rate loading on the four global uncertainty shocks as discussed in Section V.1.1.

V.1.3.c Equities Bekaert, Engstrom, and Xu (2019) show that log equity returns is quasi-affine to the state variable levels and shocks as below,

$$\widetilde{r}^e_{t+1} \equiv \ln\left(\frac{PD_{t+1} + 1}{PD_t}\frac{\widetilde{D}_{t+1}}{\widetilde{D}_t}\right), \tag{A36}$$

$$= \Omega^e_0 + \boldsymbol{\Omega^e_1 X_t} + \boldsymbol{\Omega^e_2 \omega_{t+1}} + \left[\boldsymbol{\Omega^e_2} + \ln\left(1 - \boldsymbol{\Omega^e_2}\right)\boldsymbol{S_t}\right] + \epsilon^e_{t+1}, \tag{A37}$$

where $\epsilon^e_{t+1} \sim N(0, \sigma^2_e)$ is a homoskedastic Gaussian shock to potentially capture approximation error.

V.1.3.d Equity Risk Premium Given the no-arbitrage condition, $E_t[\exp(\widetilde{m}_{t+1} + \widetilde{r}^e_{t+1})] = 1$, the global equity risk premium has a closed-form solution using the return process,

$$E_t[\widetilde{r}^e_{t+1}] - \widetilde{y}_{t,1} + \frac{1}{2}\sigma^2_e = \ln\left[(1 + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi} - \boldsymbol{\Omega^e_2}) \circ (1 + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1} \circ (1 - \boldsymbol{\Omega^e_2})^{\circ -1}\right]\boldsymbol{S_t}, \tag{A38}$$

$$\approx \left[(\boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ \boldsymbol{\Omega^e_2}\right]\boldsymbol{S_t} = -Cov_t(\widetilde{m}_{t+1}, \widetilde{r}^e_{t+1}). \tag{A39}$$

[36] Note that, the non-linearity is due to the non-linearities in the moment generating function of gamma shocks.

[37] The quadratic Taylor approximation for "$y - \ln(1+y)$" is $\frac{1}{2}y^2$.

V.1.3.e Variances

The physical variance for Asset $a \in \{b, e\}$,

$$V_t^{a,P} \equiv E_t\left[\left(\widetilde{r}_{t+1}^a - E_t(\widetilde{r}_{t+1}^a)\right)^2\right], \tag{A40}$$

$$= \boldsymbol{\Omega_2^a S_t \Omega_2^{a\prime}} + \sigma_a^2, \tag{A41}$$

where the parameter matrices are discussed in Equations (A33) and (A36).

The risk-neutral variance for Asset $a \in \{b, e\}$,

$$V_t^{a,Q} \equiv E_t^Q\left[\left(\widetilde{r}_{t+1}^a - E_t(\widetilde{r}_{t+1}^a)\right)^2\right] \tag{A42}$$

$$= \frac{\partial^2 mgf_t^Q(\widetilde{r}_{t+1}^a;\nu)}{\partial \nu^2}|_{\nu=0} - \left(\frac{\partial mgf_t^Q(\widetilde{r}_{t+1}^a;\nu)}{\partial \nu}|_{\nu=0}\right)^2 \tag{A43}$$

$$= \left[\boldsymbol{\Omega_2^a} \circ (\boldsymbol{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1}\right] \boldsymbol{S_t} \left[\boldsymbol{\Omega_2^a} \circ (\boldsymbol{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1}\right]' + \sigma_a^2, \tag{A44}$$

where the moment generating function is $mgf_t^Q(\widetilde{r}_{t+1}^a;\nu) = \frac{E_t\left[\exp\left(\widetilde{m}_{t+1}+\nu\widetilde{r}_{t+1}^a\right)\right]}{E_t[\exp(\widetilde{m}_{t+1})]}$. "$\circ$" is the Hadamard product of two identically sized matrices (or element-by-element matrix multiplication), and "$(.)^{\circ -1}$" is the Hadamard inverse. $\boldsymbol{\Omega_2^a}$ is the asset return loading vector on the common shocks, or an "amount-of-risk" loading vector; $(\boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})$ represents the nominal pricing kernel loading vector on the common shocks, or a "price-of-risk" loading vector. Intuitively, a positive downside uncertainty shock is perceived as bad news, driving up the intertemporal marginal rates of substitution; the sensitivity of the pricing kernel on the downside uncertainty shock is expected to be higher (positive) than that on the upside uncertainty shock, or $\delta_{m\theta d,t}$ in the minus m_{t+1} expression is smaller than 0 and less than $\delta_{m\theta u,t}$.

V.1.3.f Variances as Assets: Variance Risk Premium

Hence, the solutions of variances in closed form imply a premium of $V_t^{a,Q}$ over $V_t^{a,P}$. For asset $a \in \{b, e\}$,

$$VRP_t^a = V_t^{a,Q} - V_t^{a,P}$$

$$= \left[\boldsymbol{\Omega_2^a} \circ (\boldsymbol{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1}\right] \boldsymbol{S_t} \left[\boldsymbol{\Omega_2^a} \circ (\boldsymbol{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1}\right]' - \boldsymbol{\Omega_2^a S_t \Omega_2^{a\prime}}. \tag{A45}$$

V.2 Other Asset Markets

This world economy is partially integrated. Each market is complete. Each country-level state variable has a global component with constant exposures to the global levels and shocks and an idiosyncratic component. Idiosyncratic shocks are uncorrelated across countries. Under the no-arbitrage assumption, there exists closed-form solutions for country equity and bond prices.

V.2.1 Local State Variables: Matrix representation

In a matrix representation, the regional state vector denoted as $\boldsymbol{X_{t+1}^i}$ (11 × 1),

$$\begin{bmatrix}\theta_{t+1}^i & \theta u_{t+1}^i & \theta d_{t+1}^i & \pi_{t+1}^i & \pi u_{t+1}^i & \pi d_{t+1}^i & x_{t+1}^i & xu_{t+1}^i & xd_{t+1}^i & g_{t+1}^i & q_{t+1}^i\end{bmatrix}',$$

follows this general dynamics:

$$\boldsymbol{X_{t+1}^i} = \boldsymbol{\alpha_X^i} \circ \boldsymbol{\xi_{X,t}} + (\boldsymbol{1} - \boldsymbol{\alpha_X^i}) \circ \boldsymbol{\xi_{X,t}^i} + \underbrace{Jensen's\left(\boldsymbol{\alpha_X^i} \circ \boldsymbol{\delta_X^i}, \boldsymbol{S_t}\right) + Jensen's\left((\boldsymbol{1} - \boldsymbol{\alpha_X^i}) \circ \boldsymbol{X_\omega^i}, \boldsymbol{S_t^i}\right)}_{\text{Jensen's inequality terms}}$$

$$+\left(\boldsymbol{\alpha^i_X}\circ\boldsymbol{\delta^i_X}\right)\boldsymbol{\omega_{t+1}}+\left((\mathbf{1}-\boldsymbol{\alpha^i_X})\circ\boldsymbol{X^i_\omega}\right)\boldsymbol{\omega^i_{t+1}}, \tag{A46}$$

$$\boldsymbol{\omega^i_{t+1}}\sim\Gamma(\boldsymbol{S^i_t},\mathbf{1})-\boldsymbol{S^i_t}, \tag{A47}$$

where $\boldsymbol{\xi_{X,t}}$ (11 × 1) denotes the conditional mean vector of the global state variables $\boldsymbol{X_{t+1}}$ in Section V.1.1, $\boldsymbol{\omega_{t+1}}$ (9 × 1) the global state variable shock matrix, $\boldsymbol{\delta^i_X}$ (11× 9) the constant local coefficient vector to the global state variable shocks $\boldsymbol{\omega_{t+1}}$ (which are not constraint to be the same with global state variable loadings on global shocks $\boldsymbol{\delta_X}$), $\boldsymbol{S_t}$ (9 × 1) the time-varying shape parameters of global shocks, and $\Upsilon\left(\boldsymbol{\alpha^i_X}\circ\boldsymbol{\delta^i_X},\boldsymbol{S_t}\right)$ is the Jensen's inequality term from Gamma distributions. The local counterparts are defined as follows. $\boldsymbol{\xi^i_{X,t}}$ (11 × 1) denotes the local component of the conditional mean vector of the regional state variables, $\boldsymbol{\omega^i_{t+1}}$ (11 × 1) the local state variable shock matrix,

$$\begin{bmatrix}\omega^i_{\theta u,t+1} & \omega^i_{\theta d,t+1} & \omega^i_{\pi u,t+1} & \omega^i_{\pi d,t+1} & \omega^i_{x,t+1} & \omega^i_{xu,t+1} & \omega^i_{xd,t+1} & \omega^i_{g,t+1} & \omega^i_{q,t+1}\end{bmatrix}',$$

$\boldsymbol{X^i_\omega}$ (11 × 9) the constant coefficient vector to the local state variable shocks $\boldsymbol{\omega^i_{t+1}}$, $\boldsymbol{S^i_t}$ (9 × 1) the time-varying shape parameters of local shocks,

$$\begin{bmatrix}\theta u^i_t & \theta d^i_t & \pi u^i_t & \pi d^i_t & xu^i_t & xd^i_t & v^i & q^i_t\end{bmatrix}'.$$

Most important, $\boldsymbol{\alpha^i_X}$ (11 × 1) captures the constant global exposures.

The shock structures of each local state variables follow the global counterparts to ensure local shocks are also mutually independent from each other.

V.2.2 Local Real Pricing Kernel

I specify the logarithm of the local real local pricing kernel to be affine to the global and local state variable levels and shocks,

$$\begin{aligned}-m^i_{t+1}&=\alpha^i_m\left(x_t+\boldsymbol{\delta^i_m}\boldsymbol{\omega_{t+1}}\right)+(1-\alpha^i_m)\left(x^i_t+\boldsymbol{m^i_\omega}\boldsymbol{\omega^i_{t+1}}\right)\\&\quad\underbrace{+\left[\alpha^i_m\boldsymbol{\delta^i_m}-\ln\left(\mathbf{1}+\alpha^i_m\boldsymbol{\delta}^i_m\right)\right]\boldsymbol{S_t}+\left[(1-\alpha^i_m)\boldsymbol{m^i_\omega}-\ln\left(\mathbf{1}+(1-\alpha^i_m)\boldsymbol{m^i_\omega}\right)\right]\boldsymbol{S^i_t}}_{\text{Jensen's Inequality Terms}},\end{aligned} \tag{A48}$$

where $\boldsymbol{\omega_{t+1}}$ (9 × 1) and $\boldsymbol{\omega^i_{t+1}}$ (9 × 1) are the global and local state variable shock matrix defined earlier. $\boldsymbol{\delta^i_m}$ (1×9) denotes a vector of constant sensitivities to global shocks. Similarly, $\boldsymbol{m^i_\omega}$ (1×7) denotes a vector of constant sensitivities to local shocks.

The drift term, $\alpha^i_m x_t+(1-\alpha^i_m)x^i_t$, is the real regional short rate.

V.2.3 Local Asset Prices and Risk Premiums

V.2.3.a Nominal Treasury Bonds The real local short rate ($y^i_{t,1}=-\ln\{[E_t[\exp(m^i_{t+1})]\}$) and the nominal regional short rate ($\widetilde{y}^i_{t,1}=-\ln\{[E_t[\exp(m^i_{t+1}-\pi^i_{t+1})]\}$) are solved in closed forms,

$$y^i_{t,1}=\alpha^i_m x_t+(1-\alpha^i_m)x^i_t, \tag{A49}$$

$$\begin{aligned}\widetilde{y}^i_{t,1}&=\alpha^i_m x_t+\alpha^i_\pi\xi_{\pi,t}+(1-\alpha^i_m)x^i_t+(1-\alpha^i_\pi)\xi^i_{\pi,t}\\&\quad+\ln\left[(\mathbf{1}+\alpha^i_m\boldsymbol{\delta_m}+\alpha^i_\pi\boldsymbol{\delta^i_\pi})\circ(\mathbf{1}+\alpha^i_m\boldsymbol{\delta_m})^{\circ-1}\circ(\mathbf{1}+\alpha^i_\pi\boldsymbol{\delta^i_\pi})^{\circ-1}\right]\boldsymbol{S_t}\\&\quad+\ln\left[(\mathbf{1}+(1-\alpha^i_m)\boldsymbol{m^i_\omega}+(1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega})\circ(\mathbf{1}+(1-\alpha^i_m)\boldsymbol{m^i_\omega})^{\circ-1}\circ(\mathbf{1}+(1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega})^{\circ-1}\right]\boldsymbol{S^i_t}.\end{aligned} \tag{A50}$$

where "ln(.)" is the element-wise logarithm operator, "$\circ$" is the Hadamard product of two identically sized matrices (or element-by-element matrix multiplication), and "$(.)^{\circ -1}$" is the Hadamard inverse. The three components in nominal short rate represent the real short rate ($\alpha^i_m x_t + (1-\alpha^i_m)x^i_t$), the expected inflation rate ($\alpha^i_\pi \xi_{\pi,t} + (1-\alpha^i_\pi)\xi^i_{\pi,t}$), and the inflation risk premium (+ Jensen's inequality term).

The price of n-period zero-coupon nominal bond ($\widetilde{P}^{b,i}_{t,n}$) can be then solved recursively in exact closed forms, given the shock specifications. The nominal local bond return from t to $t+1$ can be approximately expressed as follows,

$$\widetilde{r}^{b,i}_{t+1,n} \equiv \ln\left(\frac{\widetilde{P}^{b,i}_{t+1,n-1}}{\widetilde{P}^{b,i}_{t,n}}\right), \tag{A51}$$

$$= \Omega^{b,i}_{0,n} + \boldsymbol{\Omega^{b,i}_{1,n} X_t} + \boldsymbol{\Omega^{b,i}_{2,n} \omega_{t+1}} + \left[\boldsymbol{\Omega^{b,i}_{2,n}} + \ln\left(1 - \boldsymbol{\Omega^{b,i}_{2,n}}\right)\boldsymbol{S_t}\right]$$
$$+ \boldsymbol{\Omega^{b,i}_{3,n} X^i_t} + \boldsymbol{\Omega^{b,i}_{4,n} \omega^i_{t+1}} + \left[\boldsymbol{\Omega^{b,i}_{4,n}} + \ln\left(1 - \boldsymbol{\Omega^{b,i}_{4,n}}\right)\boldsymbol{S^i_t}\right] + \epsilon^{b,i}_{t+1}, \tag{A52}$$

where $\epsilon^{b,i}_{t+1}$ is a homoskedastic Gaussian shock with volatility σ^i_b to capture approximation error.

V.2.3.b Bond Risk Premium Given the no-arbitrage condition, $E_t[\exp(\widetilde{m}^i_{t+1} + \widetilde{r}^{b,i}_{t+1,n})] = 1$ where $\widetilde{r}^{b,i}_{t+1,n}$ is the nominal bond return, the regional bond risk premium has a closed-form solution,

$$E_t[\widetilde{r}^{b,i}_{t+1,n}] - \widetilde{y}^i_{t,1} + \frac{1}{2}{\sigma^i_b}^2 = \underbrace{\ln\left[\left(1 + \alpha^i_m \boldsymbol{\delta_m} + \alpha^i_\pi \boldsymbol{\delta^i_\pi} - \boldsymbol{\Omega^{b,i}_{2,n}}\right) \circ \left(1 + \alpha^i_m \boldsymbol{\delta_m} + \alpha^i_\pi \boldsymbol{\delta^i_\pi}\right)^{\circ -1} \circ (1 - \boldsymbol{\Omega^{b,i}_{2,n}})^{\circ -1}\right]\boldsymbol{S_t}}_{\text{(1) compensation for global risk exposure}}$$
$$+ \underbrace{\ln\left[\left(1 + (1-\alpha^i_m)\boldsymbol{m^i_\omega} + (1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega} - \boldsymbol{\Omega^{b,i}_{4,n}}\right) \circ \left(1 + (1-\alpha^i_m)\boldsymbol{m^i_\omega} + (1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega}\right)^{\circ -1} \circ (1 - \boldsymbol{\Omega^{b,i}_{4,n}})^{\circ -1}\right]\boldsymbol{S^i_t}}_{\text{(2) compensation for regional risk exposure}}, \tag{A53}$$

[38] which in a quadratic Gaussian approximation has the following expression,

$$\approx \underbrace{\left(\alpha^i_m \boldsymbol{\delta_m} + \alpha^i_\pi \boldsymbol{\delta^i_\pi}\right) \circ \boldsymbol{\Omega^{b,i}_{2,n} S_t}}_{\approx(1)} + \underbrace{\left[(1-\alpha^i_m)\boldsymbol{m^i_\omega} + (1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega}\right] \circ \boldsymbol{\Omega^{b,i}_{4,n} S^i_t}}_{\approx(2)} = -Cov_t(\widetilde{m}^i_{t+1}, \widetilde{r}^{b,i}_{t+1,n}). \tag{A54}$$

[39]

V.2.3.c Equities The nominal local equity return from t to $t+1$ can be approximately expressed as follows,

$$\widetilde{r}^{e,i}_{t+1} \equiv \ln\left(\frac{\widetilde{P}^{e,i}_{t+1,n-1}}{\widetilde{P}^{e,i}_{t}}\right), \tag{A55}$$

$$= \Omega^{e,i}_{0} + \boldsymbol{\Omega^{e,i}_{1} X_t} + \boldsymbol{\Omega^{e,i}_{2} \omega_{t+1}} + \left[\boldsymbol{\Omega^{b,i}_{2}} + \ln\left(1 - \boldsymbol{\Omega^{b,i}_{2}}\right)\boldsymbol{S_t}\right]$$
$$+ \boldsymbol{\Omega^{e,i}_{3} X^i_t} + \boldsymbol{\Omega^{e,i}_{4} \omega^i_{t+1}} + \left[\boldsymbol{\Omega^{b,i}_{4}} + \ln\left(1 - \boldsymbol{\Omega^{b,i}_{4}}\right)\boldsymbol{S^i_t}\right] + \epsilon^{e,i}_{t+1}. \tag{A56}$$

[38] Note that, the non-linearity is due to the non-linearities in the moment generating function of Gamma shocks.

[39] The quadratic Taylor approximation for "$y - \ln(1+y)$" is $\frac{1}{2}y^2$.

where $\epsilon^{e,i}_{t+1}$ is a homoskedastic Gaussian shock with volatility σ^i_e to capture approximation error.

V.2.3.d Equity Risk Premium Given the no-arbitrage condition, $E_t[\exp(\widetilde{m}^i_{t+1}+\widetilde{r}^{e,i}_{t+1})] = 1$ where $\widetilde{r}^{e,i}_{t+1}$ is the nominal equity return, the regional equity risk premium has a closed-form solution,

$$E_t[\widetilde{r}^{e,i}_{t+1}] - \widetilde{y}^i_{t,1} + \frac{1}{2}\sigma^{i2}_b = \underbrace{\ln\left[\left(1+\alpha^i_m\boldsymbol{\delta_m}+\alpha^i_\pi\boldsymbol{\delta^i_\pi}-\boldsymbol{\Omega^{e,i}_2}\right)\circ\left(1+\alpha^i_m\boldsymbol{\delta_m}+\alpha^i_\pi\boldsymbol{\delta^i_\pi}\right)^{\circ-1}\circ(1-\boldsymbol{\Omega^{e,i}_2})^{\circ-1}\right]\boldsymbol{S_t}}_{\text{(1) compensation for global risk exposure}}$$
$$+\underbrace{\ln\left[\left(1+(1-\alpha^i_m)\boldsymbol{m^i_\omega}+(1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega}-\boldsymbol{\Omega^{e,i}_4}\right)\circ\left(1+(1-\alpha^i_m)\boldsymbol{m^i_\omega}+(1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega}\right)^{\circ-1}\circ(1-\boldsymbol{\Omega^{e,i}_4})^{\circ-1}\right]\boldsymbol{S^i_t}}_{\text{(2) compensation for regional risk exposure}}, \tag{A57}$$

[40] which in a quadratic Gaussian approximation has the following expression,

$$\approx \underbrace{\left(\alpha^i_m\boldsymbol{\delta_m}+\alpha^i_\pi\boldsymbol{\delta^i_\pi}\right)\circ\boldsymbol{\Omega^{e,i}_2 S_t}}_{\approx(1)} + \underbrace{\left[(1-\alpha^i_m)\boldsymbol{m^i_\omega}+(1-\alpha^i_\pi)\boldsymbol{\pi^i_\omega}\right]\circ\boldsymbol{\Omega^{e,i}_4 S^i_t}}_{\approx(2)} = -Cov_t(\widetilde{m}^i_{t+1},\widetilde{r}^{e,i}_{t+1}). \tag{A58}$$

V.2.3.e Variances The physical variance for Asset $a \in \{b, e\}$,

$$V^{a,i,P}_t \equiv E_t\left[\left(\widetilde{r}^{a,i}_{t+1} - E_t(\widetilde{r}^{a,i}_{t+1})\right)^2\right], \tag{A59}$$
$$= \boldsymbol{\Omega^{a,i}_2 S_t \Omega^{a,i\prime}_2} + \boldsymbol{\Omega^{a,i}_4 S^i_t \Omega^{a,i\prime}_4} + \sigma^{i2}_a, \tag{A60}$$

where the parameter matrices are discussed in Equations (A51) and (A55).

The risk-neutral variance for Asset $a \in \{b, e\}$,

$$V^{a,i,Q}_t \equiv E^Q_t\left[\left(\widetilde{r}^{a,i}_{t+1} - E_t(\widetilde{r}^{a,i}_{t+1})\right)^2\right], \tag{A61}$$
$$= \left[\boldsymbol{\Omega^{a,i}_2}\circ(\boldsymbol{1}+\boldsymbol{\delta_m}+\boldsymbol{\delta_\pi})^{\circ-1}\right]\boldsymbol{S_t}\left[\boldsymbol{\Omega^{a,i}_2}\circ(\boldsymbol{1}+\boldsymbol{\delta_m}+\boldsymbol{\delta_\pi})^{\circ-1}\right]'$$
$$+ \left[\boldsymbol{\Omega^{a,i}_4}\circ(\boldsymbol{1}+\boldsymbol{m^i_\omega}+\boldsymbol{\pi^i_\omega})^{\circ-1}\right]\boldsymbol{S^i_t}\left[\boldsymbol{\Omega^{a,i}_4}\circ(\boldsymbol{1}+\boldsymbol{m^i_\omega}+\boldsymbol{\pi^i_\omega})^{\circ-1}\right]' + \sigma^{i2}_a. \tag{A62}$$

V.2.3.f Variances as Assets: Variance Risk Premium The present tripartite model derives closed-form solutions for VRP which show potentials to capture its empirical time variation characteristics. For asset $a \in \{b, e\}$,

$$VRP^a_t = V^{a,Q}_t - V^{a,P}_t$$
$$= \left[\boldsymbol{\Omega^a_2}\circ(\boldsymbol{1}+\boldsymbol{\delta_m}+\boldsymbol{\delta_\pi})^{\circ-1}\right]\boldsymbol{S_t}\left[\boldsymbol{\Omega^a_2}\circ(\boldsymbol{1}+\boldsymbol{\delta_m}+\boldsymbol{\delta_\pi})^{\circ-1}\right]' - \boldsymbol{\Omega^a_2 S_t \Omega^{a\prime}_2}$$
$$+ \left[\boldsymbol{\Omega^{a,i}_4}\circ\left(\boldsymbol{1}+\boldsymbol{m^i_\omega}+\boldsymbol{\pi^i_\omega}\right)^{\circ-1}\right]\boldsymbol{S^i_t}\left[\boldsymbol{\Omega^{a,i}_4}\circ\left(\boldsymbol{1}+\boldsymbol{m^i_\omega}+\boldsymbol{\pi^i_\omega}\right)^{\circ-1}\right]' - \boldsymbol{\Omega^{a,i}_4 S^i_t \Omega^{a,i\prime}_4}, \tag{A63}$$

[40] Note that, the non-linearity is due to the non-linearities in the moment generating function of Gamma shocks.

where $\boldsymbol{\Omega_2^a}$ and $\boldsymbol{\Omega_4^{a,i}}$ are the "amount-of-risk" coefficients, and $\boldsymbol{\delta_m}$ and $\boldsymbol{m_\omega^i}$ are the "price-of-risk" coefficients that are linear to the global and regional risk aversions respectively. In the tripartite framework, the variance risk premium can be decomposed into a global component and a regional component.

V.2.3.g Foreign Exchange Returns Denote $s^{\$/i}$ as the log of the spot exchange rate in units of dollars per foreign currency i at region i. As stated in the Proposition 1 of Backus, Foresi, and Telmer (2011), the change in the nominal exchange rate, $\Delta s_{t+1}^{\$/i} = s_{t+1}^{\$/i} - s_t^{\$/i}$, in a frictionless world is equivalent to the nominal pricing kernel difference,

$$\Delta s_{t+1}^{\$/i} = m_{t+1}^i - m_{t+1} + \pi_{t+1} - \pi_{t+1}^i. \tag{A64}$$

An increase in $s^{\$/i}$ means a depreciation in dollars (and an appreciation in region i currency). In this model, a hypothetical world with perfect integration (i.e, $\alpha_m^i = 1\forall^i$) still obtains a time-varying spot rate to address the inflation risk amid the real macroeconomic risks. The regional currency excess return is the log return to U.S. investors of borrowing in dollars to hold foreign investment currency i can be expressed as an exact dynamic factor model,

$$\widetilde{r}_{t+1}^{fx,i} \equiv \Delta s_{t+1}^{\$/i} + \widetilde{y}_{t,1}^i, \tag{A65}$$

$$= \Omega_0^{fx,i} + \boldsymbol{\Omega_1^{fx,i} X_t} + \boldsymbol{\Omega_2^{fx,i} \omega_{t+1}} + \boldsymbol{\Omega_3^{fx,i} X_t^i} + \boldsymbol{\Omega_4^{fx,i} \omega_{t+1}^i} + \varepsilon_{t+1}^{fx,i} + Jensen's + \epsilon_{t+1}^{fx,i}, \tag{A66}$$

where $\Omega_0^{fx,i}$, $\boldsymbol{\Omega_1^{fx,i}}$,$\boldsymbol{\Omega_2^{fx,i}}$,$\boldsymbol{\Omega_3^{fx,i}}$ and $\boldsymbol{\Omega_4^{fx,i}}$ are constant matrices; $\epsilon_{t+1}^{fx,i}$ is the approximation error term that follows a homoskedastic Gaussian distribution with volatility σ_{fx}^i.

V.2.3.h Foreign Exchange Risk Premium Given the no-arbitrage condition, $E_t[\exp(\widetilde{m}_{t+1} + \widetilde{r}_{t+1}^{fx,i})] = 1$ where $\widetilde{r}_{t+1}^{fx,i}$ is the nominal foreign exchange return (from the U.S. investor's view point), the foreign exchange risk premium has a closed-form solution,

$$E_t[\widetilde{r}_{t+1}^{fx,i}] - \widetilde{y}_{t,1} + \frac{1}{2}{\sigma_{fx}^i}^2 = \ln\left[\left(1 + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi} - \boldsymbol{\Omega_2^{fx,i}}\right) \circ (1 + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi})^{\circ -1} \circ (1 - \boldsymbol{\Omega_2^{fx,i}})^{\circ -1}\right] \boldsymbol{S_t}, \tag{A67}$$

[41] which in a quadratic Gaussian approximation has the following expression,

$$\approx (\boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ \boldsymbol{\Omega_2^{fx,i} S_t} = -Cov_t(\widetilde{m}_{t+1}, \widetilde{r}_{t+1}^{fx,i}). \tag{A68}$$

[41] Note that, the non-linearity is due to the non-linearities in the moment generating function of Gamma shocks.

Table A1: Conditional Volatility Models for Asset Returns.

This table presents best GARCH-class models and distributional assumptions for asset return conditional volatility. The four GARCH-class models are GARCH ("GARCH"), exponential GARCH ("EGARCH"), Threshold GARCH ("TARCH"), and Glosten-Jagannathan-Runkle GARCH ("GJRGARCH"). The four distributions-of-interest are Gaussian (" "), Student t ("t" characterized by a tail parameter ζ_1), GED ("GED" characterized by a tail parameter ζ_1), and Skewed t ("Skewt" characterized by a tail parameter ζ_1 and an asymmetry parameter ζ_2) distributions. Suppose $r_{t+1} = \mu + \varepsilon_{t+1}$, where $\varepsilon_{t+1} \sim D(0, h_t)$.

(1) GARCH, Bollerslev (1986) : $h_t = \alpha_0 + \alpha_1 \varepsilon_t^2 + \alpha_2 h_{t-1}$

(2) EGARCH, Nelson (1991) : $\ln(h_t) = \alpha_0 + \alpha_1 \frac{|\varepsilon_t|}{\sqrt{h_{t-1}}} + \alpha_2 \ln(h_{t-1}) + \alpha_3 \frac{\varepsilon_t}{\sqrt{h_{t-1}}}$

(3) TARCH, Zakoian (1994) : $\sqrt{h_t} = \alpha_0 + \alpha_1 |\varepsilon_t| + \alpha_2 \sqrt{h_{t-1}} + \alpha_3 I_{\varepsilon_t<0} |\varepsilon_t|$

(4) GJRGARCH, Glosten, Jagannathan, and Runkle (1993) : $h_t = \alpha_0 + \alpha_1 \varepsilon_t^2 + \alpha_2 h_{t-1} + \alpha_3 I_{\varepsilon_t<0} \varepsilon_t^2$.

Model estimation uses MLE at monthly frequency covering period from March 1987 to December 2016 (T=358), and model selection follows BIC. Bold values indicate <5% significance level.

Asset	Best Model	Variance Equation Parameters			Distribution Parameters	
		α_1	α_2	α_3	Thick Tail (ζ_1)	Skew (ζ_2)
USA Equity	EGARCH-Skewt	**0.2652**	**0.8694**	**-0.1635**	**7.9925**	**-0.3664**
CAN Equity	GARCH-Skewt	**0.1111**	**0.8079**		**7.5999**	**-0.2775**
DEU Equity	EGARCH-Skewt	**0.2178**	**0.8603**	**-0.1164**	**7.3323**	**-0.2923**
FRA Equity	EGARCH-Skewt	**0.1749**	**0.8325**	**-0.2215**	21.9996	**-0.2914**
GBR Equity	EGARCH-Skewt	**0.1515**	**0.8269**	**-0.1881**	**11.3674**	**-0.1898**
CHE Equity	GJRGARCH-Skewt	0.0345	**0.2317**	**0.2989**	**6.5014**	**-0.1673**
JPN Equity	EGARCH	0.2339	**0.9369**	**-0.1193**		
AUS Equity	EGARCH-Skewt	**0.1257**	**0.9192**	-0.0685	**6.4191**	**-0.2395**
USA Gov-Bond	TARCH	**0.3669**	**0.6959**	-0.1259		
CAN Gov-Bond	GARCH-t	0.0702	**0.6549**		**9.4227**	
DEU Gov-Bond	TARCH	**0.2506**	**0.7814**	-0.0644		
FRA Gov-Bond	GARCH	**0.0774**	**0.8484**			
GBR Gov-Bond	GARCH-GED	**0.0463**	**0.9278**		**1.3353**	
CHE Gov-Bond	GARCH	**0.1284**	**0.4380**			
JPN Gov-Bond	GARCH-GED	0.1093	**0.7756**		**1.3036**	
AUS Gov-Bond	GARCH-Skewt	**0.1330**	**0.5543**		13.7548	**-0.2537**

Table A2: Values of Constant Matrices "Ξ" in the Global Dynamic Comovement Model (Equations (7) and (17) of the main paper).

In the econometric model, constant symmetric matrix $\Xi = E\left[I_{\breve{z}_t<0} I'_{\breve{z}_t<0}\right]$ $(N \times N)$ is crucial to maintain a stationary $\breve{\boldsymbol{Q}}_t$ process, where $I_{\breve{z}_t<0}$ $(N \times 1)$ is assigned 1 if the residual is less than 0, and assigned 0 otherwise. This table presents pre-determined empirical estimates of Ξ of each estimation (by asset-currency) using the sample in the econometric part of the paper (March 1987 – December 2016).

Equity, USD	USA	CAN	DEU	FRA	GBR	CHE	JPN	AUS
USA	0.43	0.34	0.31	0.34	0.34	0.31	0.30	0.30
CAN		0.46	0.31	0.34	0.35	0.31	0.30	0.34
DEU			0.46	0.37	0.36	0.34	0.31	0.29
FRA				0.47	0.36	0.34	0.33	0.32
GBR					0.50	0.36	0.35	0.36
CHE						0.47	0.33	0.30
JPN							0.50	0.33
AUS								0.47
Bond, USD	USA	CAN	DEU	FRA	GBR	CHE	JPN	AUS
USA	0.50	0.31	0.33	0.32	0.31	0.32	0.31	0.30
CAN		0.47	0.30	0.29	0.31	0.29	0.28	0.32
DEU			0.50	0.46	0.38	0.41	0.34	0.30
FRA				0.49	0.36	0.42	0.32	0.29
GBR					0.51	0.37	0.31	0.31
CHE						0.51	0.35	0.30
JPN							0.50	0.28
AUS								0.47

Table A3: Model Fit: Flight-to-Safety Channel, Given the Chosen Model in Table 3

The model implicitly include a FTS channel. To provide the right empirical moments to be compared with, "Empirical" reports the average of time-varying correlation (estimated using a parsimonious dynamic conditional correlation model as in Engle (2002)) between standardized monthly equity returns and bond returns—both denominated in USD as consistently used in this paper. Then, "Conditional Model" reports the time-series averages of the model-implied equity beta (=correlation given the standardization) Table 3. **States:** Good (Bad) states, when country recession indicator = 0 (1). Bold (italics) values indicate the model point estimates are within 95% (99%) confidence intervals of the corresponding data moments.

	Full States	Good	Bad
Empirical	0.3360	0.3799	0.2946
S.E.	(0.0481)	(0.0468)	(0.0494)
Conditional Model	**0.2501**	*0.2591*	**0.2333**

Table A4: Estimation Results of Global Equity Comovement: $x_{i,t}$ =Standardized Country Output Growth.

This table provides one of the robustness checks of the global equity correlation estimates involving the FTS channel (as in Table 3). Here, I use standardized country output growth (industrial production growth) as $x_{i,t}$ in the FTS process. Model estimation uses MLE at monthly frequency covering period from March 1987 to December 2016 (T=358), and model selection follows BIC. Bold (italics) values indicate <5% (10%) significance level.

	Multivariate Gaussian				*Multivariate t*			
	E (6)	E (7)	E (8)	E (9)	E (6)	E (7)	E (8)	E (9)
β_1	**0.0884**	**0.0777**	**0.0724**	0.0634	**0.0753**	**0.0176**	0.0490	0.0172
	(0.0291)	(0.0355)	(0.0341)	(0.0539)	(0.0353)	(0.0082)	(0.0566)	(0.0200)
β_2	**0.8708**	**0.8801**	**0.8958**	**0.9008**	**0.8864**	**0.9676**	**0.9315**	**0.9692**
	(0.0390)	(0.0450)	(0.0487)	(0.0828)	(0.0547)	(0.0111)	(0.0935)	(0.1289)
ν								
γ		*0.0255*		*0.0305*		**0.0218**		**0.0205**
		(0.0134)		(0.0183)		(0.0055)		(0.0081)
ϕ			*0.0382*	0.0264			0.0421	0.0257
			(0.0208)	(0.0215)			(0.0257)	(0.0223)
δ_1	**0.4958**	**0.4856**	**0.4943**	**0.4855**	**0.4238**	**0.4130**	**0.4221**	**0.4123**
	(0.0265)	(0.0270)	(0.0263)	(0.0263)	(0.0243)	(0.0185)	(0.0242)	(0.0656)
δ_2	**0.0686**	**0.0623**	**0.0678**	**0.0605**	**0.0387**	*0.0328*	**0.0377**	**0.0331**
	(0.0214)	(0.0219)	(0.0212)	(0.0214)	(0.0175)	(0.0185)	(0.0176)	(0.0166)
df					**11.0510**	**9.6308**	**11.1301**	**9.8784**
					(2.5636)	(1.6799)	(2.6175)	(1.9001)
LL	-2991.66	-2985.61	-2989.32	-2983.89	-2916.31	-2888.03	-2914.75	-2886.50
AIC	5991.32	5981.21	5988.64	5979.77	5842.62	5788.06	5841.49	5787.01
BIC	6006.84	6000.62	6008.04	6003.05	5862.02	5811.34	5864.78	5814.17

Table A5: Estimation Results of Global Equity Comovement: DECO Estimates, No Domestic Comovement Part.

This table provides one of the robustness checks of the global equity correlation estimates involving the FTS channel (as in Table 3). Here, I directly estimate the DECO model with tests. Model estimation uses MLE at monthly frequency covering period from March 1987 to December 2016 (T=358), and model selection follows BIC. Bold (italics) values indicate <5% (10%) significance level.

	Multivariate Gaussian					*Multivariate t*				
	E (10)	E (11)	E (12)	E (13)	E (14)	E (10)	E (11)	E (12)	E (13)	E (14)
β_1	**0.0883**	*0.0725*	**0.0497**	0.0515	**0.0985**	**0.0612**	0.0281	**0.0599**	**0.0225**	**0.1041**
	(0.0313)	(0.0384)	(0.0219)	(0.1016)	(0.0329)	(0.0138)	(0.0249)	(0.0117)	(0.0104)	(0.0287)
β_2	**0.8905**	**0.8942**	**0.9485**	**0.9058**	**0.8693**	**0.9388**	**0.9520**	**0.9401**	**0.9617**	**0.8482**
	(0.0431)	(0.0449)	(0.0281)	(0.1418)	(0.0444)	(0.0143)	(0.0348)	(0.0123)	(0.0142)	(0.0349)
ν					**0.2072**					**0.2800**
					(0.0539)					(0.0358)
γ		**0.0259**		0.0188			**0.0279**		**0.0233**	
		(0.0106)		(0.0136)			(0.0135)		(0.0065)	
ϕ			*0.0432*	**0.0394**				*0.0259*	*0.0386*	
			(0.0252)	(0.0201)				(0.0141)	(0.0207)	
δ_1										
δ_2										
df						**11.3522**	**9.8748**	**11.6657**	**10.1025**	**10.6052**
						(2.5334)	(1.8115)	(2.6764)	(1.9130)	(2.1257)
LL	-3120.24	-3117.03	-3116.13	-3114.15	-3120.47	-3042.07	-3025.19	-3038.64	-3023.17	-3042.15
AIC	6244.48	6240.06	6238.25	6236.31	6246.94	6090.13	6058.37	6085.28	6056.33	6092.29
BIC	6252.24	6251.70	6249.89	6251.83	6258.58	6101.77	6073.90	6100.80	6075.74	6107.81

Table A6: Estimation Results of the Latent U.S. (Global) Output Growth Upside and Downside Uncertainties and Shocks.

I follow Bekaert, Engstrom, and Xu (2019) to model both the real upside uncertainty (θu_t) and real downside uncertainty (θd_t) from decomposing the industrial production growth shocks, and use their estimation results in the present research. The (log) global real growth rate of technology (or output growth), θ_t, has time-varying conditional moments governed by two state variables: θu_t (upside uncertainty) and θd_t (downside uncertainty). Formally, θ_t has the following process,

$$\theta_{t+1} = \overline{\theta} + \rho_{\theta\theta}(\theta_t - \overline{\theta}) + \rho_{\theta\theta u}(\theta u_t - \overline{\theta u}) + \rho_{\theta\theta d}(\theta d_t - \overline{\theta d}) + u^{\theta}_{t+1}, \tag{A69}$$

where the growth shock is decomposed into two independent shocks,

$$u^{\theta}_{t+1} = \delta_{\theta\theta u}\omega_{\theta u,t+1} - \delta_{\theta\theta d}\omega_{\theta d,t+1}. \tag{A70}$$

The shocks follow de-meaned Gamma distributions with time-varying shape parameters,

$$\omega_{\theta u,t+1} \sim \widetilde{\Gamma}\left(\theta u_t, 1\right) \tag{A71}$$

$$\omega_{\theta d,t+1} \sim \widetilde{\Gamma}\left(\theta d_t, 1\right), \tag{A72}$$

where $\widetilde{\Gamma}\left(y, 1\right)$ denotes a de-meaned Gamma-distributed random variable with shape parameter y and a unit scale parameter. The shape factors, θu_t and θd_t, follow autoregressive processes,

$$\theta u_{t+1} = \overline{\theta u} + \rho_{\theta u}(\theta u_t - \overline{\theta u}) + \delta_{\theta u}\omega_{\theta u,t+1} \tag{A73}$$

$$\theta d_{t+1} = \overline{\theta d} + \rho_{\theta d}(\theta d_t - \overline{\theta d}) + \delta_{\theta d}\omega_{\theta d,t+1}, \tag{A74}$$

where ρ_y denotes the autoregressive term of process y_{t+1}, δ_y the sensitivity to $\omega_{y,t+1}$, and $\overline{y}$ the constant long-run mean. Given that Gamma distributions are right-skewed by design, the growth shock with a negative loading on $\omega_{\theta d,t+1}$ influences the negative skewness, and θd_t positive skewness.

	θ_t	VARC	θu_t	θd_t
	Conditional Mean			
mean	-1.01E-04		500	**12.9194**
	(4.39E-04)		(fix)	(1.7274)
AR	**0.1395**	79.40%	**0.9993**	**0.9040**
	(0.0328)		(0.0002)	(0.0152)
$\rho_{\theta\theta u}$	1.31E-05	7.66%		
	(4.72E-04)			
$\rho_{\theta\theta d}$	**-2.18E-04**	12.94%		
	(2.39E-05)			
	Shock Structure			
$\omega_{\theta u,t}$ loading	**1.12E-04**	25.04%	**0.7860**	
	(1.10E-05)		(0.0843)	
$\omega_{\theta d,t}$ loading	**-0.0019**	74.96%		**2.0579**
	(0.0002)			(0.1485)

Table A7: Estimation Results of the Latent U.S. (Global) Inflation Upside and Downside Uncertainties and Shocks.

The U.S. inflation rate has the following process,

$$\pi_{t+1} = \overline{\pi} + \rho_{\pi\theta}(\theta_t - \overline{\theta}) + \rho_{\pi\theta u}(\theta u_t - \overline{\theta u}) + \rho_{\pi\theta d}(\theta d_t - \overline{\theta d}) + \rho_{\pi\pi}(\pi_t - \overline{\pi}) + \rho_{\pi\pi u}(\pi u_t - \overline{\pi u}) + \rho_{\pi\pi d}(\pi d_t - \overline{\pi d}) + u^{\pi}_{t+1}, \tag{A75}$$

where θ_t denotes the change in log industrial production index (real) from $t-1$ to t, θu_t the real upside uncertainty and θd_t the real downside uncertainty. The estimates of θu_t and θd_t are obtained from Table A6. π_t denotes the inflation rate, πu_t the nominal upside uncertainty and πd_t the nominal downside uncertainty. The nominal upside and downside uncertainties are latent variables in this system. $\overline{x}$ denotes the unconditional mean of Variable x; $\rho_{\pi x}$ denotes the sensitivity of inflation to Variable x in the conditional mean process. The inflation disturbance, u^{π}_{t+1}, is sensitive to the two real uncertainty shocks and the two nominal uncertainty shocks that are mutually independent of one another,

$$u^{\pi}_{t+1} = (\delta_{\pi\theta u}\omega_{\theta u,t+1} + \delta_{\pi\theta d}\omega_{\theta d,t+1}) + (\delta_{\pi\pi u}\omega_{\pi u,t+1} - \delta_{\pi\pi d}\omega_{\pi d,t+1}). \tag{A76}$$

The shocks follow de-meaned Gamma distributions with time-varying shape parameters,

$$\omega_{\pi u,t+1} \sim \widetilde{\Gamma}(\pi u_t, 1) \tag{A77}$$

$$\omega_{\pi d,t+1} \sim \widetilde{\Gamma}(\pi d_t, 1), \tag{A78}$$

$$\pi u_{t+1} = \overline{\pi u} + \rho_{\pi u}(\pi u_t - \overline{\pi u}) + \delta_{\pi u}\omega_{\pi u,t+1} \tag{A79}$$

$$\pi d_{t+1} = \overline{\pi d} + \rho_{\pi d}(\pi d_t - \overline{\pi d}) + \delta_{\pi d}\omega_{\pi d,t+1}. \tag{A80}$$

The estimation of the inflation system uses Bates (2006)'s filtration-based AML estimation. Sample period ranges from January 1947 to December 2016. Bold (italic) values indicate <5% (10%) significance level.

A. π_t Shock Structure			
$\omega_{\theta u,t}$	$\omega_{\theta d,t}$	$\omega_{\pi u,t}$	$\omega_{\pi d,t}$
-8.49E-06	8.58E-06	**4.22E-04**	**-3.56E-04**
(1.39E-06)	(1.57E-05)	(1.90E-05)	(8.78E-06)
B. πu_t, Upside Uncertainty			
$\overline{\pi u}$	AR	$\omega_{\pi u,t}$	
3.9091	**0.9730**	**1.4593**	
(1.1494)	(0.0082)	(0.1963)	
C. πd_t, Downside Uncertainty			
$\overline{\pi d}$	AR	$\omega_{\pi d,t}$	
100	**0.9881**	**0.1915**	
(fix)	(0.0219)	(0.0055)	

Table A8: Estimation Results of the Latent U.S. (Global) Real Short Rate Upside and Downside Uncertainties and Shocks.

Assume a reduced-form (minus) real pricing kernel,

$$-m_{t+1} = x_t + [\boldsymbol{\delta_m} - \ln(1+\boldsymbol{\delta_m})]\boldsymbol{S_t} + \boldsymbol{\delta_m}\boldsymbol{\omega_{t+1}}, \tag{A81}$$

where the shock structure is determined by a linear combination of shocks in the U.S. economy: risk aversion shock denoted as ω_q (Bekaert, Engstrom, and Xu, 2019), real upside uncertainty shock $\omega_{\theta u}$ (This Paper, Table A6), real downside uncertainty shock $\omega_{\theta d}$ (This Paper, Table A6), nominal upside and downside uncertainty shocks $\omega_{\pi u}$ and $\omega_{\pi d}$ (This Paper, Table A7). The shocks are assumed to follow Gamma distributions with time-varying shape parameters,

$$\boldsymbol{\omega_{t+1}} \sim \Gamma(\boldsymbol{S_t}, \boldsymbol{1}) - \boldsymbol{S_t}. \tag{A82}$$

Given the no-arbitrage assumption and the inflation process as in Table A7, one-period real interest rate can be shown to be x_t, and one-period nominal interest rate is,

$$\begin{aligned}\widetilde{y}_{t,1} &= -\ln\{[E_t[\exp(m_{t+1} - \pi_{t+1})]\} \\ &= x_t + \underbrace{\xi_{\pi,t} + \ln\left[(\boldsymbol{1} + \boldsymbol{\delta_m} + \boldsymbol{\delta_\pi}) \circ (\boldsymbol{1} + \boldsymbol{\delta_m})^{\circ -1} \circ (\boldsymbol{1} + \boldsymbol{\delta_\pi})^{\circ -1}\right]\boldsymbol{S_t}}_{\text{inflation compensation}},\end{aligned} \tag{A83}$$

where inflation shock loadings $\boldsymbol{\delta_\pi} = [\delta_{\pi\theta u}, \delta_{\pi\theta d}, \delta_{\pi\pi u}, -\delta_{\pi\pi d}]$ and expected inflation rate $\xi_{\pi,t}$ are presented in Table A7. The real short rate is assumed with the following reduced-form expression,

$$\begin{aligned}x_{t+1} = \overline{x} &+ \rho_{x\theta}(\theta_t - \overline{\theta}) + \rho_{x\theta u}(\theta u_t - \overline{\theta u}) + \rho_{x\theta d}(\theta d_t - \overline{\theta d}) + \rho_{x\pi}(\pi_t - \overline{\pi}) + \rho_{x\pi u}(\pi u_t - \overline{\pi u}) + \rho_{x\pi d}(\pi d_t - \overline{\pi d}) \\ &+ \rho_{xx}(x_t - \overline{x}) + \rho_{xxu}(xu_t - \overline{xu}) + \rho_{xxd}(xd_t - \overline{xd}) + \rho_{xq}(q_t - \overline{q}) + u^x_{t+1},\end{aligned} \tag{A84}$$

where the short rate shock is sensitive to the real and nominal uncertainty shocks as well as a short rate-specific homoskedastic shock,

$$u^x_{t+1} = \delta_{xq}\omega_{q,t+1} + (\delta_{x\theta u}\omega_{\theta u,t+1} + \delta_{x\theta d}\omega_{\theta d,t+1}) + (\delta_{x\pi u}\omega_{\pi u,t+1} + \delta_{x\pi d}\omega_{\pi d,t+1}) + \delta_{xu}\omega_{xu,t+1} - \delta_{xd}\omega_{xd,t+1}, \tag{A85}$$

where the short rate-specific shocks are assumed to follow de-meaned Gamma distributions with time-varying shape parameters,

$$\omega_{xu,t+1} \sim \widetilde{\Gamma}(xu_t, 1), xu_{t+1} = \overline{xu} + \rho_{xu}(xu_t - \overline{xu}) + \delta_{xu}\omega_{xu,t+1}, \tag{A86}$$

$$\omega_{xd,t+1} \sim \widetilde{\Gamma}(xd_t, 1), xd_{t+1} = \overline{xd} + \rho_{xd}(xd_t - \overline{xd}) + \delta_{xd}\omega_{xd,t+1}. \tag{A87}$$

The estimation of the inflation system uses Bates (2006)'s filtration-based AML estimation; the unknown parameters are $\boldsymbol{\delta_m}, \delta_\pi, \delta_{xu}, \delta_{xd}, \rho_{xu}, \rho_{xd}$, and other parameters can be derived using linear projection within the system; the estimation outputs are ω_{xu}, ω_{xd}, xu, xd and x. Sample period begins when first risk aversion estimate is available, 1986/06-2015/02). Bold (italic) values indicate <5% (10%) significance level.

A. x_t Shock Structure						
$\omega_{q,t}$	$\omega_{\theta u,t}$	$\omega_{\theta d,t}$	$\omega_{\pi u,t}$	$\omega_{\pi d,t}$	$\omega_{xu,t}$	$\omega_{xd,t}$
-0.7579	**-0.0039**	*-0.0322*	**-0.2428**	**0.0959**	**0.0379**	**-0.0500**
(0.7662)	(0.0058)	(0.0520)	(0.0568)	(0.0212)	(0.0008)	(0.0012)
B. xu_t, Upside Uncertainty						
$\overline{xu}$	AR	$\omega_{xu,t}$				
22.9586	**0.8759**	**5.9808**				
(0.9786)	(0.0408)	(0.3801)				
C. xd_t, Downside Uncertainty						
$\overline{xd}$	AR	$\omega_{xd,t}$				
8.9025	**0.8536**	**4.9358**				
(2.5225)	(0.0419)	(0.2301)				

Table A9: Factor Exposures of Global Asset Returns in a Seemingly Unrelated Regression (SUR) Frameworks; Constant Beta.

In this table, I jointly estimate the constant exposures of global equity and bond returns to global factor shocks in a SUR framework. The error terms may have cross-equation contemporaneous correlations. SUR models are estimated with MLE. The sample period covers from March 1987 to February 2015; February 2015 is the last month given the availability of the risk aversion estimate from Bekaert, Engstrom, and Xu (2019). Standard errors are shown in the parantenses. Bold (italics) values indicate <5% (10%) significance level.

	ω_q		$\omega_{\theta u}$		$\omega_{\theta d}$		$\omega_{\pi u}$		$\omega_{\pi d}$		ω_{xu}		ω_{xd}	
Panel A. Returns in USD														
USA Equity	**-0.1734**	(0.0128)	**-0.0003**	(0.0001)	-0.0001	(0.0008)	**-0.0022**	(0.0010)	0.0001	(0.0004)	0.0002	(0.0002)	0.0003	(0.0002)
CAN Equity	**-0.1811**	(0.0178)	**-0.0005**	(0.0001)	-0.0006	(0.0011)	**-0.0038**	(0.0015)	**-0.0016**	(0.0005)	-0.0001	(0.0003)	*0.0006*	(0.0003)
DEU Equity	**-0.2245**	(0.0218)	-0.0001	(0.0001)	0.0004	(0.0014)	*-0.0032*	(0.0018)	-0.0004	(0.0006)	0.0004	(0.0003)	0.0003	(0.0004)
FRA Equity	**-0.1942**	(0.0202)	**-0.0003**	(0.0001)	-0.0005	(0.0013)	**-0.0040**	(0.0016)	-0.0001	(0.0006)	**0.0007**	(0.0003)	0.0005	(0.0003)
GBR Equity	**-0.1452**	(0.0163)	**-0.0004**	(0.0001)	-0.0014	(0.0010)	-0.0017	(0.0013)	-0.0002	(0.0005)	*-0.0005*	(0.0003)	0.0002	(0.0003)
CHE Equity	**-0.1524**	(0.0170)	**-0.0003**	(0.0001)	-0.0009	(0.0011)	-0.0010	(0.0014)	0.0002	(0.0005)	0.0001	(0.0003)	0.0004	(0.0003)
JPN Equity	**-0.0833**	(0.0225)	-0.0001	(0.0002)	0.0018	(0.0014)	-0.0021	(0.0018)	-0.0003	(0.0006)	-0.0001	(0.0004)	0.0005	(0.0004)
AUS Equity	**-0.1829**	(0.0220)	**-0.0007**	(0.0001)	-0.0020	(0.0014)	*-0.0031*	(0.0018)	-0.0007	(0.0006)	-0.0005	(0.0004)	**0.0008**	(0.0004)
USA Gov-Bond	**0.0280**	(0.0076)	0.0000	(0.0001)	0.0007	(0.0005)	**-0.0016**	(0.0006)	**0.0005**	(0.0002)	0.0000	(0.0001)	-0.0001	(0.0001)
CAN Gov-Bond	**-0.0345**	(0.0103)	0.0000	(0.0001)	0.0009	(0.0007)	**-0.0027**	(0.0008)	-0.0003	(0.0003)	-0.0001	(0.0002)	0.0002	(0.0002)
DEU Gov-Bond	0.0095	(0.0123)	0.0000	(0.0001)	0.0005	(0.0008)	**-0.0024**	(0.0010)	**-0.0009**	(0.0004)	0.0000	(0.0002)	0.0000	(0.0002)
FRA Gov-Bond	0.0043	(0.0121)	0.0000	(0.0001)	0.0004	(0.0008)	**-0.0027**	(0.0010)	**-0.0008**	(0.0003)	0.0000	(0.0002)	0.0000	(0.0002)
GBR Gov-Bond	**0.0241**	(0.0119)	0.0001	(0.0001)	0.0002	(0.0008)	-0.0014	(0.0010)	-0.0004	(0.0003)	*-0.0003*	(0.0002)	0.0000	(0.0002)
CHE Gov-Bond	0.0125	(0.0134)	0.0001	(0.0001)	0.0003	(0.0009)	-0.0014	(0.0011)	-0.0003	(0.0004)	-0.0002	(0.0002)	0.0000	(0.0002)
JPN Gov-Bond	**0.0334**	(0.0142)	0.0000	(0.0001)	0.0002	(0.0009)	0.0010	(0.0012)	-0.0002	(0.0004)	0.0000	(0.0002)	0.0001	(0.0002)
AUS Gov-Bond	**-0.0467**	(0.0132)	**-0.0003**	(0.0001)	*-0.0014*	(0.0008)	**-0.0030**	(0.0011)	*-0.0006*	(0.0004)	-0.0003	(0.0002)	*0.0004*	(0.0002)
Panel B. Returns in LC														
USA Equity	**-0.1734**	(0.0128)	**-0.0003**	(0.0001)	-0.0001	(0.0008)	**-0.0022**	(0.0010)	0.0001	(0.0004)	0.0002	(0.0002)	0.0003	(0.0002)
CAN Equity	**-0.1397**	(0.0142)	**-0.0004**	(0.0001)	-0.0008	(0.0009)	-0.0017	(0.0012)	*-0.0008*	(0.0004)	0.0001	(0.0002)	*0.0004*	(0.0002)
DEU Equity	**-0.2058**	(0.0206)	-0.0002	(0.0001)	0.0004	(0.0013)	-0.0018	(0.0017)	0.0009	(0.0006)	0.0005	(0.0003)	0.0005	(0.0003)
FRA Equity	**-0.1747**	(0.0187)	**-0.0003**	(0.0001)	-0.0005	(0.0012)	*-0.0027*	(0.0015)	**0.0011**	(0.0005)	**0.0008**	(0.0003)	**0.0007**	(0.0003)
GBR Equity	**-0.1478**	(0.0143)	**-0.0004**	(0.0001)	-0.0014	(0.0009)	-0.0015	(0.0012)	*0.0008*	(0.0004)	-0.0003	(0.0002)	0.0003	(0.0002)
CHE Equity	**-0.1467**	(0.0164)	**-0.0004**	(0.0001)	-0.0012	(0.0010)	-0.0011	(0.0013)	**0.0010**	(0.0005)	0.0002	(0.0003)	**0.0006**	(0.0003)
JPN Equity	**-0.1035**	(0.0207)	-0.0001	(0.0001)	0.0016	(0.0013)	**-0.0034**	(0.0017)	0.0002	(0.0006)	0.0000	(0.0003)	*0.0006*	(0.0003)
AUS Equity	**-0.1182**	(0.0163)	**-0.0005**	(0.0001)	-0.0001	(0.0010)	-0.0005	(0.0013)	0.0002	(0.0005)	-0.0003	(0.0003)	0.0004	(0.0003)
USA Gov-Bond	**0.0280**	(0.0076)	0.0000	(0.0001)	0.0007	(0.0005)	**-0.0016**	(0.0006)	**0.0005**	(0.0002)	0.0000	(0.0001)	-0.0001	(0.0001)
CAN Gov-Bond	0.0070	(0.0074)	0.0000	(0.0000)	0.0007	(0.0005)	-0.0006	(0.0006)	**0.0006**	(0.0002)	0.0000	(0.0001)	0.0000	(0.0001)
DEU Gov-Bond	**0.0282**	(0.0056)	0.0000	(0.0000)	0.0005	(0.0004)	**-0.0010**	(0.0005)	**0.0004**	(0.0002)	0.0000	(0.0001)	0.0001	(0.0001)
FRA Gov-Bond	**0.0238**	(0.0061)	0.0000	(0.0000)	0.0004	(0.0004)	**-0.0014**	(0.0005)	**0.0005**	(0.0002)	0.0000	(0.0001)	0.0001	(0.0001)
GBR Gov-Bond	**0.0215**	(0.0070)	0.0000	(0.0000)	0.0002	(0.0004)	**-0.0012**	(0.0006)	**0.0006**	(0.0002)	-0.0001	(0.0001)	0.0001	(0.0001)
CHE Gov-Bond	**0.0181**	(0.0050)	0.0000	(0.0000)	0.0000	(0.0003)	**-0.0015**	(0.0004)	**0.0004**	(0.0001)	-0.0001	(0.0001)	**0.0002**	(0.0001)
JPN Gov-Bond	**0.0133**	(0.0061)	0.0000	(0.0000)	0.0000	(0.0004)	-0.0003	(0.0005)	0.0003	(0.0002)	0.0000	(0.0001)	0.0001	(0.0001)
AUS Gov-Bond	**0.0180**	(0.0078)	-0.0001	(0.0001)	0.0005	(0.0005)	-0.0004	(0.0006)	0.0003	(0.0002)	-0.0001	(0.0001)	-0.0001	(0.0001)

Table A10: Factor Exposures of Global Asset Returns in Seemingly Unrelated Regression (SUR) Framework; USD; Time-Varying Beta.

In this table, I jointly estimate the time-varying exposures of global equity and bond returns (in USD) to global factor shocks in a SUR framework. The error terms may have cross-equation contemporaneous correlations. SUR models are estimated with MLE. The sample period covers from March 1987 to February 2015. Standard errors are shown in the parantenses. Bold (italics) values indicate <5% (10%) significance level.

β_0	ω_q		$\omega_{\theta u}$		$\omega_{\theta d}$		$\omega_{\pi u}$		$\omega_{\pi d}$		ω_{xu}		ω_{xd}	
USA Equity	**-0.1687**	(0.0129)	**-0.0003**	(0.0001)	0.0011	(0.0010)	*-0.0034*	(0.0018)	0.0002	(0.0004)	0.0001	(0.0002)	0.0003	(0.0002)
CAN Equity	**-0.1790**	(0.0179)	**-0.0005**	(0.0001)	0.0011	(0.0015)	-0.0031	(0.0024)	**-0.0015**	(0.0005)	-0.0003	(0.0003)	*0.0007*	(0.0003)
DEU Equity	**-0.2254**	(0.0220)	-0.0001	(0.0002)	0.0020	(0.0018)	0.0001	(0.0030)	-0.0005	(0.0007)	0.0006	(0.0004)	0.0002	(0.0004)
FRA Equity	**-0.1932**	(0.0205)	**-0.0003**	(0.0001)	0.0007	(0.0017)	-0.0016	(0.0028)	-0.0001	(0.0006)	**0.0008**	(0.0004)	0.0003	(0.0004)
GBR Equity	**-0.1432**	(0.0163)	**-0.0004**	(0.0001)	0.0007	(0.0013)	-0.0006	(0.0022)	-0.0002	(0.0005)	*-0.0005*	(0.0003)	-0.0001	(0.0003)
CHE Equity	**-0.1493**	(0.0172)	**-0.0003**	(0.0001)	0.0001	(0.0014)	-0.0003	(0.0023)	0.0002	(0.0005)	0.0001	(0.0003)	0.0003	(0.0003)
JPN Equity	**-0.0858**	(0.0225)	-0.0001	(0.0002)	*0.0035*	(0.0018)	0.0005	(0.0031)	-0.0001	(0.0007)	-0.0001	(0.0004)	0.0005	(0.0004)
AUS Equity	**-0.1846**	(0.0222)	**-0.0007**	(0.0002)	-0.0008	(0.0018)	0.0004	(0.0030)	-0.0004	(0.0007)	*-0.0006*	(0.0004)	*0.0007*	(0.0004)
USA Gov-Bond	**0.0303**	(0.0078)	0.0000	(0.0001)	*0.0010*	(0.0006)	0.0001	(0.0013)	**0.0005**	(0.0002)	0.0001	(0.0001)	-0.0002	(0.0002)
CAN Gov-Bond	**-0.0386**	(0.0105)	0.0000	(0.0001)	*0.0016*	(0.0008)	0.0013	(0.0017)	-0.0002	(0.0003)	-0.0002	(0.0002)	0.0001	(0.0002)
DEU Gov-Bond	-0.0024	(0.0125)	0.0001	(0.0001)	0.0010	(0.0010)	0.0003	(0.0020)	**-0.0008**	(0.0004)	-0.0002	(0.0002)	-0.0002	(0.0002)
FRA Gov-Bond	-0.0083	(0.0122)	0.0000	(0.0001)	0.0009	(0.0010)	0.0002	(0.0020)	**-0.0007**	(0.0003)	-0.0002	(0.0002)	-0.0002	(0.0002)
GBR Gov-Bond	0.0134	(0.0122)	0.0001	(0.0001)	0.0002	(0.0010)	0.0006	(0.0020)	-0.0003	(0.0003)	**-0.0004**	(0.0002)	-0.0003	(0.0002)
CHE Gov-Bond	-0.0012	(0.0137)	0.0001	(0.0001)	-0.0001	(0.0011)	0.0005	(0.0022)	-0.0003	(0.0004)	-0.0003	(0.0002)	-0.0002	(0.0003)
JPN Gov-Bond	**0.0314**	(0.0146)	0.0000	(0.0001)	-0.0003	(0.0012)	-0.0008	(0.0024)	-0.0002	(0.0004)	-0.0001	(0.0002)	0.0002	(0.0003)
AUS Gov-Bond	**-0.0614**	(0.0132)	**-0.0002**	(0.0001)	-0.0013	(0.0010)	0.0027	(0.0022)	-0.0004	(0.0004)	**-0.0005**	(0.0002)	0.0002	(0.0003)
β_1 for Equities	$\omega_q * s_e$		$\omega_{\theta u} * s_e$		$\omega_{\theta d} * s_e$		$\omega_{\pi u} * s_e$		$\omega_{\pi d} * s_e$		$\omega_{xu} * s_e$		$\omega_{xd} * s_e$	
USA Equity	-0.0068	(0.0142)	0.0001	(0.0001)	*-0.0011*	(0.0006)	0.0006	(0.0008)	0.0006	(0.0006)	-0.0004	(0.0003)	0.0000	(0.0002)
CAN Equity	-0.0144	(0.0198)	-0.0001	(0.0002)	**-0.0020**	(0.0008)	-0.0004	(0.0011)	0.0002	(0.0008)	*-0.0009*	(0.0005)	-0.0003	(0.0003)
DEU Equity	**-0.0527**	(0.0243)	0.0000	(0.0002)	-0.0016	(0.0010)	**-0.0029**	(0.0014)	-0.0011	(0.0010)	0.0003	(0.0006)	-0.0001	(0.0004)
FRA Equity	-0.0299	(0.0226)	0.0002	(0.0002)	-0.0013	(0.0010)	-0.0018	(0.0013)	-0.0009	(0.0009)	-0.0003	(0.0005)	-0.0001	(0.0003)
GBR Equity	-0.0109	(0.0181)	0.0001	(0.0002)	**-0.0020**	(0.0008)	-0.0013	(0.0010)	-0.0007	(0.0007)	-0.0001	(0.0004)	0.0001	(0.0003)
CHE Equity	*-0.0349*	(0.0190)	0.0003	(0.0002)	-0.0007	(0.0008)	-0.0010	(0.0011)	-0.0002	(0.0008)	0.0001	(0.0005)	0.0001	(0.0003)
JPN Equity	**-0.0537**	(0.0249)	0.0002	(0.0002)	-0.0013	(0.0011)	-0.0015	(0.0014)	0.0011	(0.0010)	-0.0001	(0.0006)	0.0003	(0.0004)
AUS Equity	**-0.0500**	(0.0245)	0.0000	(0.0002)	-0.0014	(0.0010)	-0.0017	(0.0014)	0.0002	(0.0010)	-0.0008	(0.0006)	0.0000	(0.0004)
β_1 for Bonds	$\omega_q * s_b$		$\omega_{\theta u} * s_b$		$\omega_{\theta d} * s_b$		$\omega_{\pi u} * s_b$		$\omega_{\pi d} * s_b$		$\omega_{xu} * s_b$		$\omega_{xd} * s_b$	
USA Gov-Bond	0.0035	(0.0068)	0.0000	(0.0001)	0.0006	(0.0005)	*0.0018*	(0.0010)	-0.0003	(0.0003)	**-0.0003**	(0.0001)	-0.0002	(0.0001)
CAN Gov-Bond	0.0138	(0.0092)	0.0000	(0.0001)	**0.0017**	(0.0007)	**0.0036**	(0.0013)	-0.0001	(0.0003)	0.0001	(0.0002)	0.0000	(0.0002)
DEU Gov-Bond	**0.0372**	(0.0109)	*0.0002*	(0.0001)	0.0008	(0.0008)	0.0018	(0.0015)	-0.0003	(0.0004)	0.0001	(0.0002)	-0.0002	(0.0002)
FRA Gov-Bond	**0.0370**	(0.0106)	**0.0002**	(0.0001)	0.0011	(0.0008)	0.0020	(0.0015)	-0.0004	(0.0004)	0.0002	(0.0002)	-0.0001	(0.0002)
GBR Gov-Bond	**0.0276**	(0.0106)	**0.0002**	(0.0001)	0.0003	(0.0008)	0.0010	(0.0015)	0.0001	(0.0004)	0.0003	(0.0002)	-0.0003	(0.0002)
CHE Gov-Bond	**0.0411**	(0.0120)	0.0002	(0.0001)	-0.0003	(0.0009)	0.0010	(0.0017)	0.0002	(0.0004)	0.0001	(0.0002)	0.0000	(0.0002)
JPN Gov-Bond	-0.0011	(0.0128)	0.0001	(0.0001)	-0.0010	(0.0009)	-0.0021	(0.0018)	**-0.0012**	(0.0005)	0.0001	(0.0002)	0.0000	(0.0003)
AUS Gov-Bond	**0.0350**	(0.0116)	0.0000	(0.0001)	0.0010	(0.0008)	**0.0042**	(0.0016)	*-0.0007*	(0.0004)	**0.0005**	(0.0002)	0.0000	(0.0002)

Table A11: Factor Exposures of Global Asset Returns in a SUR Framework; Local Currencies; Time-Varying Beta.

In this table, I jointly estimate the time-varying exposures of global equity and bond returns (in local currencies) to global factor shocks in a SUR framework. The error terms may have cross-equation contemporaneous correlations. SUR models are estimated with MLE. The sample period covers from March 1987 to February 2015. Standard errors are shown in the parantenses. Bold (italics) values indicate <5% (10%) significance level.

β_0	ω_q		$\omega_{\theta u}$		$\omega_{\theta d}$		$\omega_{\pi u}$		$\omega_{\pi d}$		ω_{xu}		ω_{xd}	
USA Equity	**-0.1687**	(0.0129)	**-0.0003**	(0.0001)	0.0011	(0.0010)	*-0.0034*	(0.0018)	0.0002	(0.0004)	0.0001	(0.0002)	0.0003	(0.0002)
CAN Equity	**-0.1401**	(0.0144)	**-0.0004**	(0.0001)	0.0005	(0.0012)	-0.0007	(0.0020)	-0.0007	(0.0004)	0.0000	(0.0002)	*0.0005*	(0.0003)
DEU Equity	**-0.2066**	(0.0209)	-0.0001	(0.0001)	0.0016	(0.0017)	-0.0002	(0.0029)	0.0008	(0.0006)	0.0006	(0.0004)	0.0006	(0.0004)
FRA Equity	**-0.1734**	(0.0190)	**-0.0003**	(0.0001)	0.0004	(0.0015)	-0.0021	(0.0026)	*0.0011*	(0.0006)	**0.0008**	(0.0003)	*0.0007*	(0.0004)
GBR Equity	**-0.1472**	(0.0145)	**-0.0004**	(0.0001)	-0.0004	(0.0012)	-0.0016	(0.0020)	**0.0010**	(0.0004)	-0.0004	(0.0003)	0.0002	(0.0003)
CHE Equity	**-0.1452**	(0.0167)	**-0.0003**	(0.0001)	-0.0004	(0.0014)	-0.0014	(0.0023)	**0.0010**	(0.0005)	0.0001	(0.0003)	**0.0007**	(0.0003)
JPN Equity	**-0.1048**	(0.0206)	-0.0001	(0.0001)	**0.0033**	(0.0017)	-0.0006	(0.0028)	0.0006	(0.0006)	-0.0003	(0.0004)	0.0006	(0.0004)
AUS Equity	**-0.1179**	(0.0165)	**-0.0005**	(0.0001)	0.0014	(0.0013)	0.0005	(0.0023)	0.0003	(0.0005)	-0.0003	(0.0003)	0.0003	(0.0003)
USA Gov-Bond	**0.0256**	(0.0080)	0.0000	(0.0001)	0.0007	(0.0005)	**-0.0015**	(0.0006)	0.0003	(0.0002)	0.0001	(0.0002)	-0.0001	(0.0001)
CAN Gov-Bond	0.0065	(0.0078)	0.0000	(0.0001)	0.0007	(0.0005)	-0.0006	(0.0006)	**0.0005**	(0.0002)	0.0002	(0.0002)	0.0000	(0.0001)
DEU Gov-Bond	**0.0272**	(0.0060)	0.0000	(0.0000)	0.0005	(0.0004)	**-0.0010**	(0.0005)	**0.0003**	(0.0002)	0.0001	(0.0002)	0.0001	(0.0001)
FRA Gov-Bond	**0.0221**	(0.0065)	0.0000	(0.0000)	0.0004	(0.0004)	**-0.0014**	(0.0005)	**0.0005**	(0.0002)	0.0001	(0.0002)	0.0001	(0.0001)
GBR Gov-Bond	**0.0224**	(0.0074)	0.0000	(0.0000)	0.0002	(0.0004)	*-0.0012*	(0.0006)	**0.0005**	(0.0002)	0.0001	(0.0002)	0.0000	(0.0001)
CHE Gov-Bond	**0.0192**	(0.0053)	0.0000	(0.0000)	0.0000	(0.0003)	**-0.0015**	(0.0004)	**0.0004**	(0.0001)	0.0000	(0.0001)	0.0001	(0.0001)
JPN Gov-Bond	**0.0168**	(0.0065)	0.0000	(0.0000)	0.0000	(0.0004)	-0.0005	(0.0005)	*0.0003*	(0.0002)	0.0000	(0.0002)	0.0000	(0.0001)
AUS Gov-Bond	**0.0182**	(0.0081)	**-0.0001**	(0.0001)	0.0006	(0.0005)	-0.0002	(0.0006)	0.0001	(0.0002)	0.0001	(0.0002)	-0.0002	(0.0001)
β_1 for Equities	$\omega_q * s_e$		$\omega_{\theta u} * s_e$		$\omega_{\theta d} * s_e$		$\omega_{\pi u} * s_e$		$\omega_{\pi d} * s_e$		$\omega_{xu} * s_e$		$\omega_{xd} * s_e$	
USA Equity	-0.0068	(0.0142)	0.0001	(0.0001)	*-0.0011*	(0.0006)	0.0006	(0.0008)	0.0006	(0.0006)	-0.0004	(0.0003)	0.0000	(0.0002)
CAN Equity	-0.0105	(0.0159)	-0.0001	(0.0001)	**-0.0014**	(0.0007)	-0.0006	(0.0009)	0.0001	(0.0006)	-0.0004	(0.0004)	-0.0002	(0.0002)
DEU Equity	-0.0186	(0.0231)	0.0001	(0.0002)	-0.0012	(0.0010)	-0.0016	(0.0013)	-0.0007	(0.0009)	0.0002	(0.0006)	-0.0002	(0.0003)
FRA Equity	0.0048	(0.0210)	0.0003	(0.0002)	-0.0008	(0.0009)	-0.0004	(0.0012)	-0.0004	(0.0008)	-0.0003	(0.0005)	-0.0002	(0.0003)
GBR Equity	0.0005	(0.0160)	0.0001	(0.0001)	-0.0008	(0.0007)	0.0002	(0.0009)	0.0007	(0.0006)	-0.0003	(0.0004)	0.0002	(0.0002)
CHE Equity	0.0043	(0.0184)	**0.0004**	(0.0002)	-0.0005	(0.0008)	0.0002	(0.0010)	0.0004	(0.0007)	-0.0002	(0.0004)	0.0000	(0.0003)
JPN Equity	**-0.0537**	(0.0228)	0.0002	(0.0002)	*-0.0016*	(0.0010)	-0.0011	(0.0013)	0.0014	(0.0009)	-0.0009	(0.0006)	0.0002	(0.0003)
AUS Equity	-0.0217	(0.0182)	0.0001	(0.0002)	*-0.0013*	(0.0008)	-0.0008	(0.0010)	0.0003	(0.0007)	-0.0002	(0.0004)	0.0001	(0.0003)
β_1 for Bonds	$\omega_q * s_b$		$\omega_{\theta u} * s_b$		$\omega_{\theta d} * s_b$		$\omega_{\pi u} * s_b$		$\omega_{\pi d} * s_b$		$\omega_{xu} * s_b$		$\omega_{xd} * s_b$	
USA Gov-Bond	*0.0150*	(0.0082)	0.0000	(0.0000)	0.0004	(0.0005)	0.0005	(0.0009)	**0.0007**	(0.0002)	0.0001	(0.0002)	0.0000	(0.0001)
CAN Gov-Bond	0.0123	(0.0081)	0.0000	(0.0000)	-0.0001	(0.0005)	0.0005	(0.0009)	**0.0005**	(0.0002)	0.0001	(0.0002)	0.0000	(0.0001)
DEU Gov-Bond	0.0097	(0.0062)	0.0000	(0.0000)	-0.0002	(0.0004)	0.0002	(0.0007)	*0.0003*	(0.0002)	0.0001	(0.0001)	0.0000	(0.0001)
FRA Gov-Bond	0.0042	(0.0067)	0.0001	(0.0000)	-0.0005	(0.0004)	0.0003	(0.0007)	0.0003	(0.0002)	0.0000	(0.0001)	-0.0001	(0.0001)
GBR Gov-Bond	0.0055	(0.0077)	0.0001	(0.0000)	-0.0001	(0.0005)	0.0007	(0.0008)	**0.0004**	(0.0002)	0.0002	(0.0002)	-0.0002	(0.0001)
CHE Gov-Bond	0.0059	(0.0055)	0.0000	(0.0000)	0.0001	(0.0003)	0.0008	(0.0006)	0.0002	(0.0002)	0.0001	(0.0001)	-0.0001	(0.0001)
JPN Gov-Bond	-0.0047	(0.0067)	0.0000	(0.0000)	-0.0002	(0.0004)	**0.0021**	(0.0007)	0.0001	(0.0002)	0.0001	(0.0001)	-0.0001	(0.0001)
AUS Gov-Bond	*0.0148*	(0.0084)	**0.0002**	(0.0001)	0.0007	(0.0005)	-0.0001	(0.0009)	0.0003	(0.0002)	0.0002	(0.0002)	-0.0001	(0.0001)

Table A12: Conditional Variance Decomposition.

Panel A. Constant Beta

	ω_q	$\omega_{\theta u}$	$\omega_{\theta d}$	$\omega_{\pi u}$	$\omega_{\pi d}$	ω_{xu}	ω_{xd}	Explained
USA Equity	93.6%	4.0%	0.0%	1.2%	0.2%	0.3%	0.6%	56.7%
CAN Equity	71.3%	7.2%	0.2%	2.4%	17.1%	0.0%	1.7%	47.4%
DEU Equity	95.4%	0.5%	0.1%	1.6%	0.9%	1.0%	0.6%	39.6%
FRA Equity	88.1%	3.9%	0.2%	2.9%	0.2%	3.2%	1.5%	37.3%
GBR Equity	84.6%	8.8%	2.0%	1.0%	0.6%	2.6%	0.4%	33.9%
CHE Equity	89.8%	7.0%	0.8%	0.4%	0.4%	0.1%	1.5%	33.7%
JPN Equity	76.2%	1.8%	7.8%	3.4%	3.7%	0.1%	7.1%	8.2%
AUS Equity	72.9%	15.0%	2.2%	1.7%	3.1%	1.3%	3.9%	33.8%
USA Gov-Bond	43.4%	0.2%	5.6%	9.0%	40.5%	0.1%	1.3%	13.9%
CAN Gov-Bond	57.0%	0.6%	7.7%	18.1%	10.6%	1.9%	4.0%	9.4%
DEU Gov-Bond	3.2%	1.2%	2.4%	12.2%	80.7%	0.2%	0.1%	8.7%
FRA Gov-Bond	0.9%	0.3%	1.3%	17.5%	79.8%	0.1%	0.1%	7.4%
GBR Gov-Bond	38.7%	6.4%	0.5%	8.6%	30.7%	15.1%	0.0%	5.1%
CHE Gov-Bond	20.7%	7.6%	2.0%	15.5%	43.8%	10.0%	0.4%	2.1%
JPN Gov-Bond	78.8%	1.7%	0.5%	5.2%	13.0%	0.3%	0.6%	3.3%
AUS Gov-Bond	36.3%	16.2%	7.3%	9.4%	21.1%	4.4%	5.3%	14.3%

Panel B. Time-Varying Beta

	ω_q		$\omega_{\theta u}$		$\omega_{\theta d}$		$\omega_{\pi u}$		$\omega_{\pi d}$		ω_{xu}		ω_{xd}		Explained
	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	β_0	β_1	
USA Equity	87.6%	0.1%	3.6%	0.2%	0.9%	0.8%	2.4%	0.2%	0.6%	2.0%	0.0%	0.7%	0.9%	0.0%	60.2%
CAN Equity	68.1%	0.2%	8.2%	0.3%	0.6%	1.8%	1.3%	0.1%	14.2%	0.1%	0.4%	1.8%	2.4%	0.6%	52.7%
DEU Equity	87.2%	2.2%	0.4%	0.0%	1.7%	0.7%	0.0%	1.9%	1.3%	2.9%	1.5%	0.1%	0.2%	0.1%	50.3%
FRA Equity	86.0%	1.1%	3.0%	0.4%	0.2%	0.7%	0.4%	1.2%	0.1%	2.8%	3.2%	0.2%	0.7%	0.0%	41.3%
GBR Equity	82.1%	0.2%	7.6%	0.1%	0.5%	2.6%	0.1%	1.0%	0.3%	2.7%	2.7%	0.1%	0.0%	0.1%	38.3%
CHE Equity	87.4%	2.6%	5.1%	1.9%	0.0%	0.3%	0.0%	0.8%	0.5%	0.3%	0.2%	0.1%	0.7%	0.1%	35.8%
JPN Equity	55.0%	6.7%	0.7%	2.0%	19.0%	1.1%	0.1%	1.0%	0.3%	9.1%	0.4%	0.0%	4.1%	0.4%	19.5%
AUS Equity	72.3%	2.8%	15.2%	0.0%	0.3%	0.8%	0.0%	1.1%	0.9%	0.2%	2.2%	1.3%	2.7%	0.0%	38.6%
USA Gov-Bond	33.2%	0.3%	0.2%	0.5%	8.8%	1.9%	0.1%	5.4%	31.2%	7.0%	0.3%	4.1%	4.4%	2.7%	24.1%
CAN Gov-Bond	46.9%	3.7%	0.2%	0.3%	17.1%	10.1%	2.8%	12.0%	2.4%	1.0%	2.4%	0.8%	0.3%	0.0%	20.1%
DEU Gov-Bond	0.2%	18.6%	1.6%	4.7%	5.8%	2.3%	0.1%	3.5%	52.8%	3.3%	1.9%	0.7%	3.8%	0.8%	15.8%
FRA Gov-Bond	2.2%	17.8%	0.8%	6.6%	5.7%	3.5%	0.1%	4.0%	44.6%	6.9%	2.2%	1.9%	3.3%	0.4%	16.9%
GBR Gov-Bond	10.6%	16.9%	7.8%	10.9%	0.5%	0.4%	1.5%	1.7%	11.6%	0.2%	18.2%	5.1%	10.1%	4.4%	10.6%
CHE Gov-Bond	0.1%	38.6%	6.6%	7.8%	0.3%	0.5%	1.7%	1.7%	20.7%	3.2%	10.7%	1.0%	7.1%	0.2%	8.5%
JPN Gov-Bond	33.8%	0.0%	1.0%	2.6%	1.0%	2.4%	1.6%	3.5%	5.4%	43.9%	1.4%	0.6%	2.8%	0.0%	15.8%
AUS Gov-Bond	40.3%	7.6%	9.8%	0.0%	4.0%	1.5%	4.8%	7.0%	5.6%	8.8%	6.2%	3.5%	0.9%	0.0%	29.0%

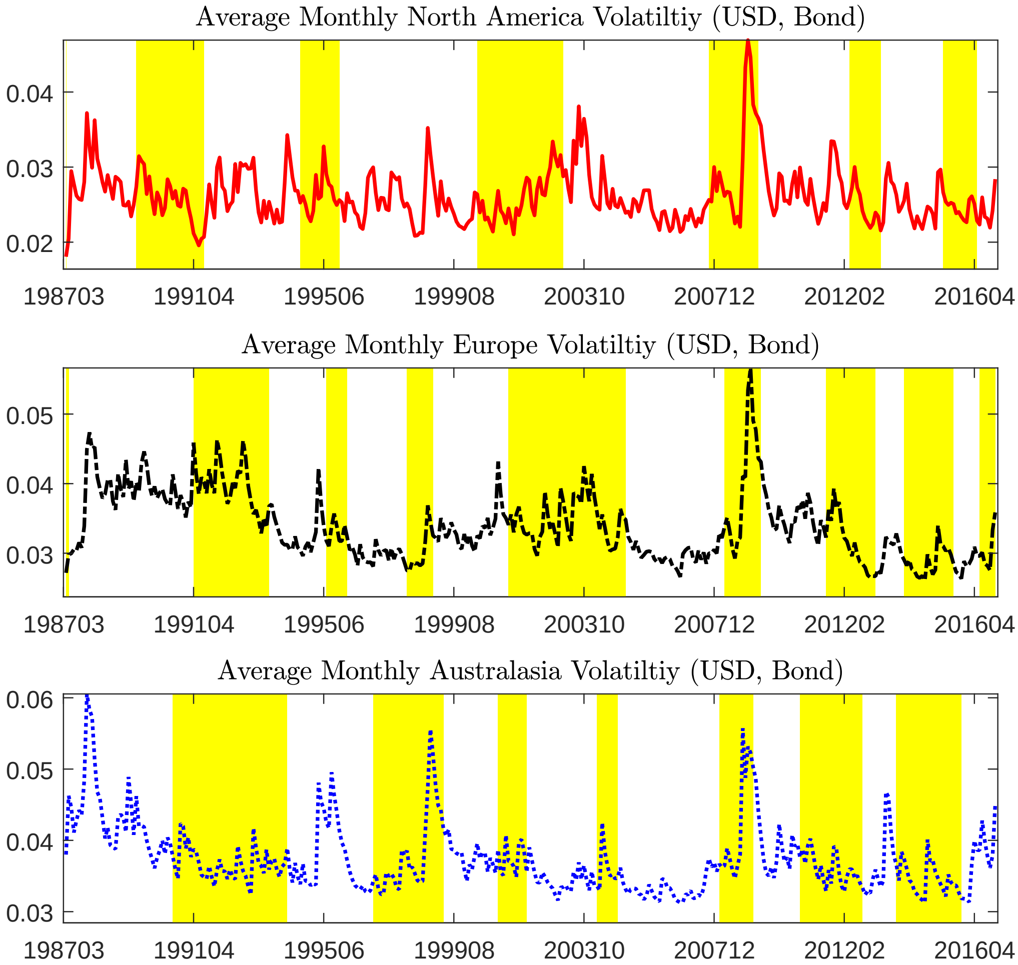

Figure A1: Average (equal-weight) monthly USD-denominated bond return conditional volatility for North America, Europe, and Australasia.

The shaded regions are OECD recession indicators (from peak to trough) for United States (top plot), Germany (middle plot), and Japan (bottom plot) obtained from Federal Reserve Bank of St. Louis. More details on obtaining the conditional volatilities are shown in Table A1 in the main manuscript.

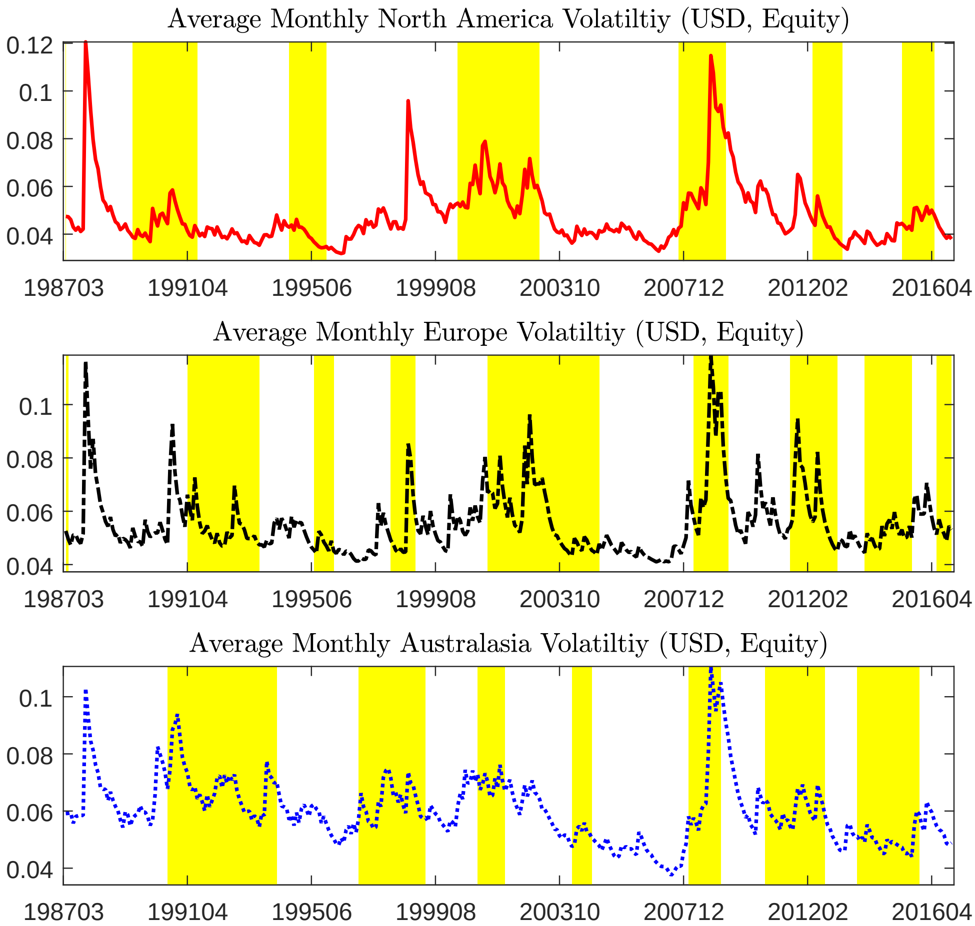

Figure A2: Average (equal-weight) monthly USD-denominated equity return conditional volatility for North America, Europe, and Australasia.

The shaded regions are OECD recession indicators (from peak to trough) for United States (top plot), Germany (middle plot), and Japan (bottom plot) obtained from Federal Reserve Bank of St. Louis. More details on obtaining the conditional volatilities are shown in Table 2 of the main paper.

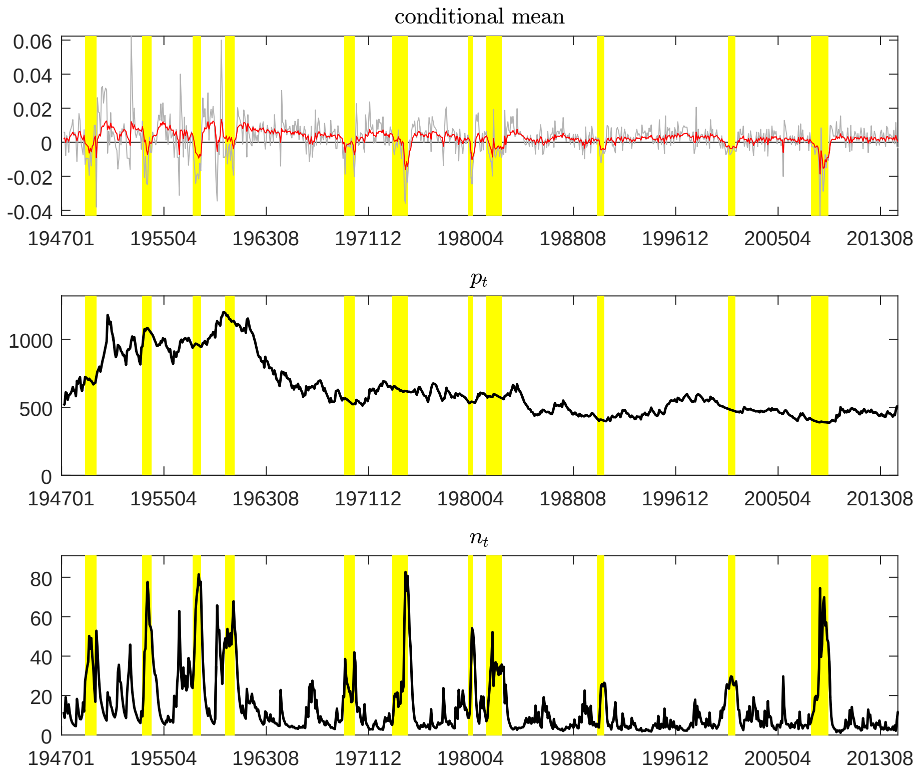

Figure A3: Estimation Results of the U.S. Real Upside (θu) and Downside (θd) Uncertainties; sample period begins from 1947/01 to 2016/12.

The model is detailed in Table A6. The shaded regions are U.S. NBER recession indicators.

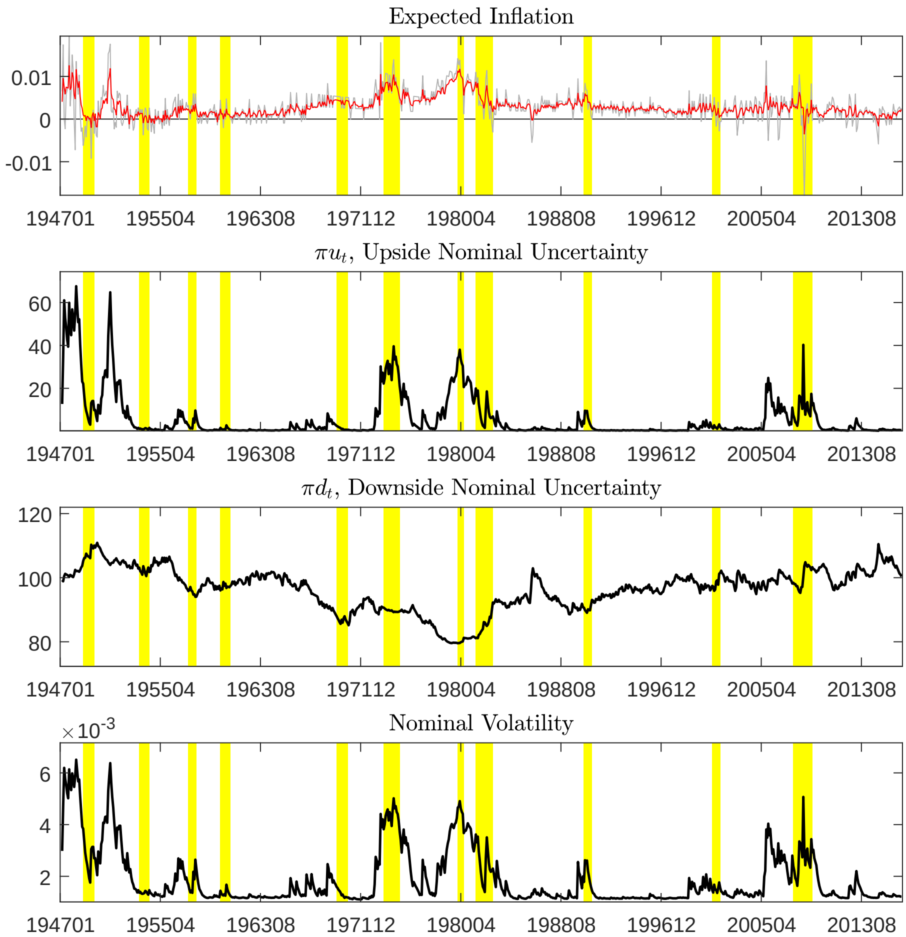

Figure A4: Estimation Results of the U.S. Inflation Upside (πu) and Downside (πd) Uncertainties (Long Sample, 1947/01-2016/12).

The model is detailed in Table A7. The shaded regions are U.S. NBER recession indicators.

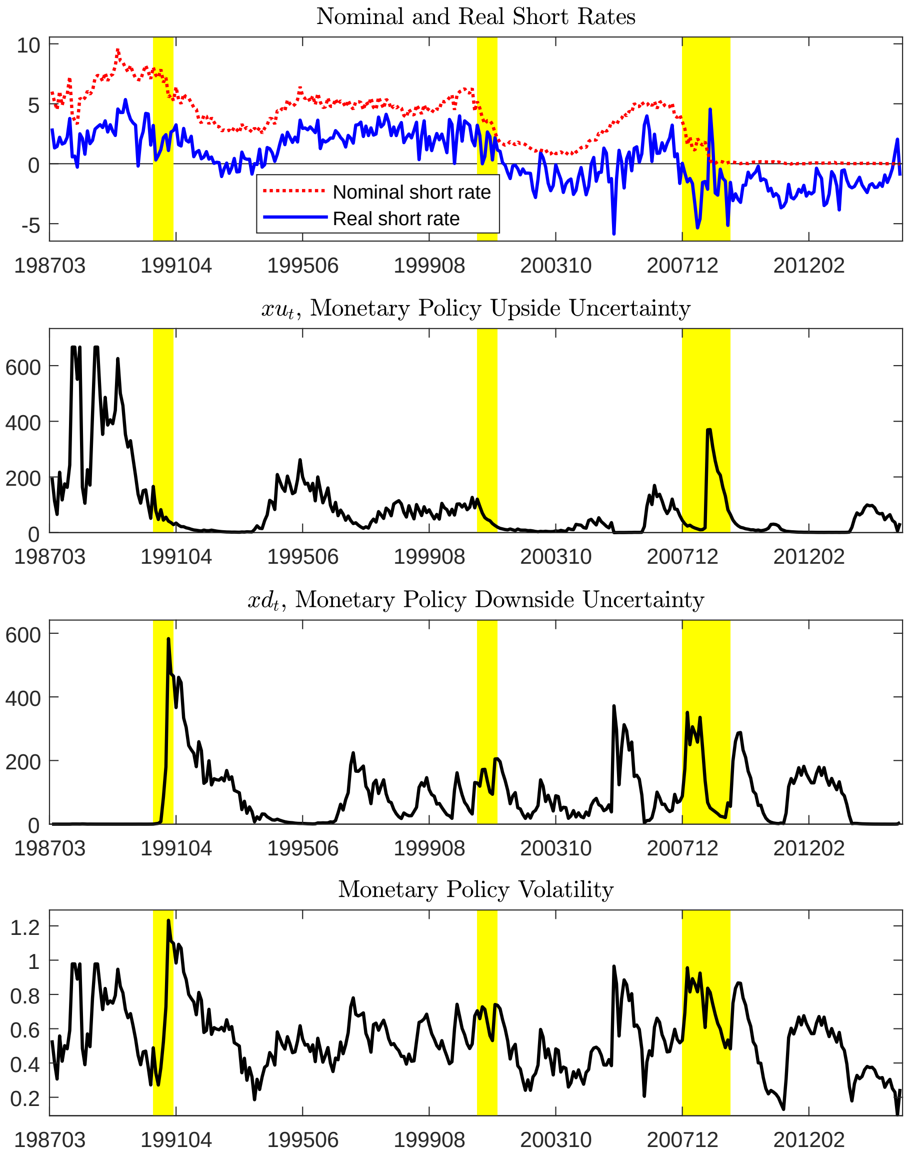

Figure A5: Estimation Results of the U.S. Real Short Rate Upside (xu) and Downside (xd) Uncertainties; sample period begins when first risk aversion estimate is available, 1986/06-2015/02).

The model is detailed in Table A8. The shaded regions are U.S. NBER recession indicators.

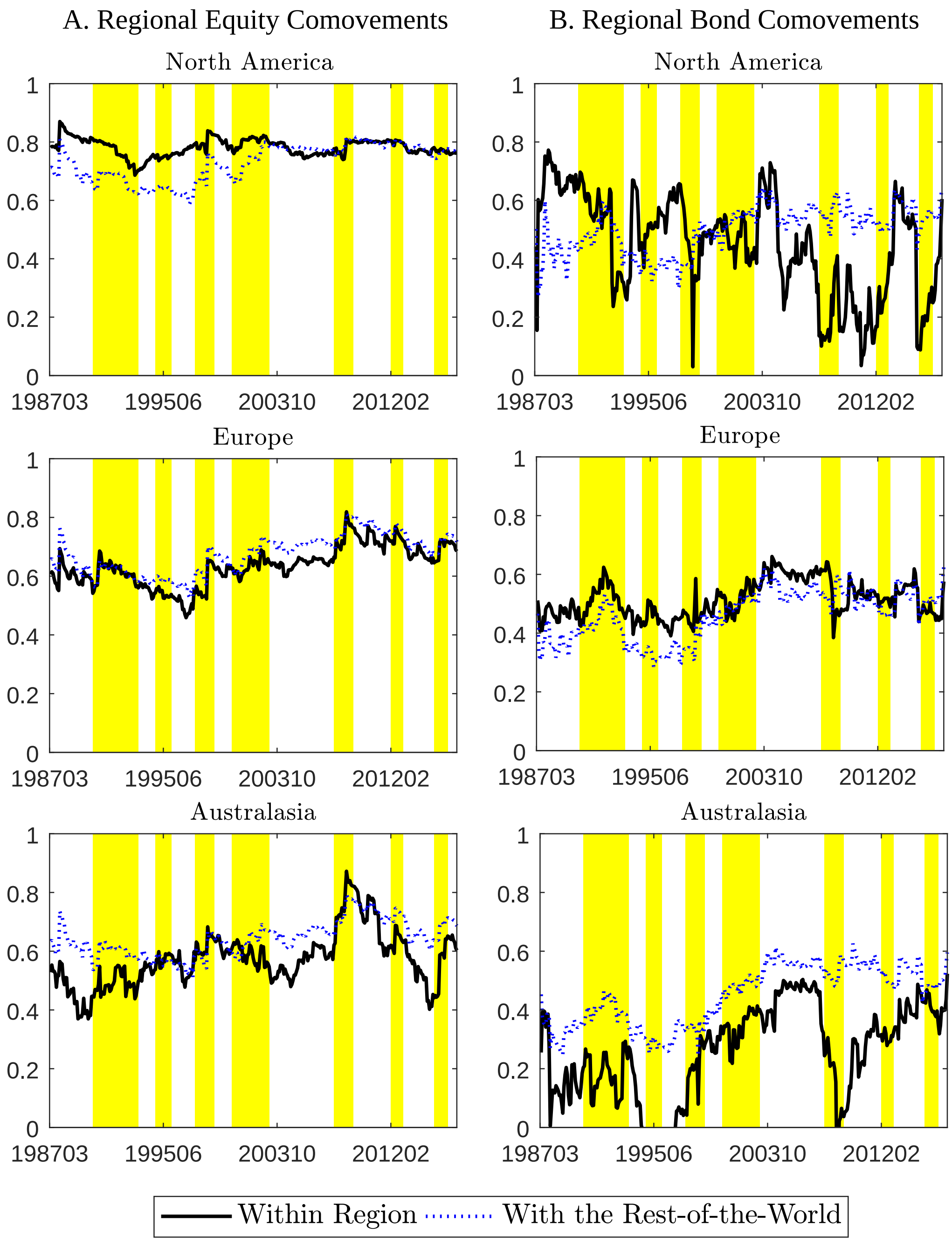

Figure A6: Regional Dynamic Comovements.

This figure presents the dynamics of a region's internal correlation (solid lines) and its correlation with the rest-of-the-world (dotted lines). Both correlations are constructed using equal averages and across unique country pairs. alternative global return correlation estimates using the average of pairwise DCC models (dashed lines) and using local currency returns (right plot). The shaded regions are OECD world recession months from the OECD website.