Inspecting Cross-Border Macro-Financial Mechanisms

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The views expressed are our own and do not represent the official stance and views of Bank of England, its committees, ECB, Banco de España or the Eurosystem.
Inspecting Cross-Border Macro-Financial Mechanisms

1. **In a nutshell**
2. **Empirical set-up**
   - Method
3. **Results**
   - Cross-border spillovers
   - Theoretical underpinnings
4. **Concluding remarks**
5. **Annex**
   - Data
   - One country results - Cycles
   - One country results - Macro-financial linkages
   - One country results - cross-sector transmissions
   - One country results - factor loadings
   - One country results - FEVD
   - Alternative estimations - robustness checks
   - Estimation algorithm

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In a nutshell

Linkages, interactions or interdependences?

- How deep are macro-financial cross-border transmissions between US and Euro Area?
- How has the interdependence in the world’s largest economic block evolved since Bretton Woods? And since financial liberalization?
- How dominant is the US, and has it substantially transformed over time?
- How much should the Fed/ECB be concerned with shocks originated in the other economy?
- Are the interactions between the real and financial sector stronger in the US or Euro Area?

First study of macro-financial spillovers between the U.S. and the Euro Area, each as single economic units, both from an empirical and theoretical point of view.
In a nutshell

Dimensions in our analysis
In a nutshell

Key findings

**Insights from this study: EMPIRICS**

- Asymmetric cross-border transmission of US shocks, which has intensified over time.

- Intensity in the transmission of shocks increases over time, at least until the Great Recession.

- Some pushback in asymmetry from 2008 onwards.

- The introduction of the EURO did not manage to alter the hegenmoncy of the U.S. in the bilateral relations.

- We observe crossborder ‘substitution effect’, akin to flight-to-safety in the Euro Area.
In a nutshell

Key findings 2

Insights from this study cont: THEORY

- The transmission of US TFP shocks is significantly larger and more persistent than any alternative shock specifications.
- Result remains even in a symmetric shock scenario.
- US is a more leveraged economy, which accentuates the financial accelerator effect.
- We find a heftier (relative to Euro Area) transmission of financial shocks to U.S. real activity in our empirical estimates.
The empirical literature can be divided into two main branches:

- **BRANCH 1: Measurement of the cycles**: Frequency-based filters; extracting cycles in frequency domain; turning point identification; model-based filters (Kalman-filter approaches).

- **BRANCH 2: Changes over time in the relationship between macro and financial cycles**: VARs subject to parameter instabilities (abrupt or smooth).

Current paper unifies these and extends by:

- identify outward as well as inward spillovers in the U.S. and the euro area, both within the sector as well as across them.
- we allow the degree of spillover effects between the two regions to exhibit potential changes over time.

- **DSGE models with cross-border macro-financial mechanisms.** However, none of these papers have considered US-Euro Area spill-overs.
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Subsection 1

Method
The two economies are jointly modeled (including the factors and shocks).

Structure given by *sign, exclusion, & timing restrictions*.

All autoregressive coefficients and coefficients measuring sensitivity of cycles to shocks are allowed to evolve over time.

Re-estimate the full model using *break in volatility in 1985*.

In particular, we define $\Sigma_{S_t}$, where $S_t = (0; 1)$ is a variable that differentiate between regimes of low and high volatility, respectively.

Emprical set-up

Data categories

All variables are expressed in growth rates. Financial ratios and spreads are expressed in levels. On the financial side, we include:

- *Price variables* include corporate financing spreads, financial ratios of firms, and stock market indices.

- *Quantities* include assets and liabilities of banks (including their subcomponents), assets and liabilities of households and firms (along with their subcomponents), credit, monetary system net foreign assets and liabilities, monetary aggregates, and velocity of money.

On the real side, we include macroeconomic aggregates and supply-side variables such as:

- GDP and its aggregate demand components

- labour market indicators, and variables capturing productivity and the supply side of the economy such as real output per hour, unit labor costs, and compensation to employees.
Empirical set-up

Global (joint) model

\[
\begin{bmatrix}
F_{t}^{US} \\
R_{t}^{US} \\
F_{t}^{EA} \\
R_{t}^{EA}
\end{bmatrix}
= 
\begin{bmatrix}
\Lambda_{f,t}^{US} & 0 & 0 & 0 \\
0 & \Lambda_{r,t}^{US} & 0 & 0 \\
0 & 0 & \Lambda_{f,t}^{EA} & 0 \\
0 & 0 & 0 & \Lambda_{r,t}^{EA}
\end{bmatrix}
\begin{bmatrix}
f_{t}^{US} \\
r_{t}^{US} \\
f_{t}^{EA} \\
r_{t}^{EA}
\end{bmatrix}
+ 
\begin{bmatrix}
v_{t}^{US} \\
v_{t}^{US} \\
v_{t}^{EA} \\
v_{t}^{EA}
\end{bmatrix}
\tag{1}
\]

\[
\begin{bmatrix}
f_{t}^{US} \\
r_{t}^{US} \\
f_{t}^{EA} \\
r_{t}^{EA}
\end{bmatrix}
= 
\Psi_{1,t}
\begin{bmatrix}
f_{t-1}^{US} \\
r_{t-1}^{US} \\
f_{t-1}^{EA} \\
r_{t-1}^{EA}
\end{bmatrix}
+ \cdots + 
\Psi_{k,t}
\begin{bmatrix}
f_{t-k}^{US} \\
r_{t-k}^{US} \\
f_{t-k}^{EA} \\
r_{t-k}^{EA}
\end{bmatrix}
+ 
\begin{bmatrix}
u_{t}^{US} \\
u_{t}^{US} \\
u_{t}^{EA} \\
u_{t}^{EA}
\end{bmatrix}
\tag{2}
\]

where \( F_{t}^{US} \) and \( R_{t}^{US} \) denote the set of information on financial and real activity, respectively, for the U.S. economy. Similarly, \( F_{t}^{EA} \) and \( R_{t}^{EA} \) denote the same set of information but for the Euro Area economy. Notice that, consequently, this joint model would extract four latent factors.
Global (joint) model

\( \mathbf{v}_t^x \sim N(0, \text{diag}(\Omega)). \mathbf{u}_t^x \sim N(0, \Sigma). X = (US, EA). \) To allow for changes over time in the information contained in the cycles and in the propagation of shocks between real and financial cycles, we let both the autoregressive coefficients \( \psi_t = \text{vec}(\Psi_t) \), and the factor loadings \( \lambda_t = \text{vec}(\Lambda_t) \) to be time-varying by following random walk dynamics:

\[
\psi_t = \psi_{t-1} + \mathbf{w}_t, \quad (3)
\]

\[
\lambda^x_t = \lambda^x_{t-1} + \mathbf{\omega}_t. \quad (4)
\]
### Empirical set-up

#### Identification scheme - global (joint) model

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<td>Financial Cycle U.S.</td>
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<td>Real Cycle U.S.</td>
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<td>0</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

*Note:* The symbol * indicates that no restriction is imposed in the corresponding relationship.
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Subsection 1

Cross-border spillovers
Results
Multi-layer approach

- *Layer 1*: Assess the evolving strength of commonalities within each of the two sectors.
- *Layer 2*: Characterize the joint propagation of macroeconomic and financial shocks.
- *Layer 3*: Disentangle the complex cross-border transmission, both within and across sectors.
Layer 1
Dimensions in our analysis
Results

Layer 1

(a) Euro Area Financial Cycle

(b) Euro Area Real Cycle

(c) U.S. Financial Cycle

(d) U.S. Real Cycle
Results

Layer 1

- While financial activity underwent two larger contractions during our sample period (1992 and 2008), macroeconomic activity experienced more (albeit shorter) downturns.

- The financial cycle experienced a profound change in frequency around 1990.

- Yet differences in the individual drivers of cycles. In Euro Area, indicators containing information about credit and balance sheet variables have increased their correlation with the financial cycle over time (stable in US).
Layer 2
Dimensions in our analysis
Results

Layer 2 - within economies

(a) Real and Financial of U.S.

(b) Real and Financial of E.A.
Results

Layer 2 - within economies

- Contemporaneous time-varying correlation has been larger in the case of the Euro Area.

- In the case of the U.S., the correlation has varied significantly over time. It almost doubled in less than 30 years, up until the eve of the GFC.

- After the Single European Act in 1987, the correlation started to steadily grow, reaching close to 0.7 by the new millennium. Notice that the collapse of the European Stability Mechanism in 1992 did not interrupt this long-term trend of macro-financial deepening.

- We see a sharp correlation reversal following the Great Recession in both economies.
Layer 3
Dimensions in our analysis
Results

Layer 3 - Cross-border impulse responses: US - to - EA
Results

Layer 3 - Cross-border impulse responses: EA - to - US
Results
Layer 3 - Cross-border spillovers US-EA-US

Cross-border spillovers:

- The impact of US shocks is much larger than those coming from Euro Area.
- Shocks from Euro Area only have transitory (or very temporary) effects.
- The effects turn even negative, in particular on US financial cycle, that one could believe that there is some type of substitution going on between the two economies.
- Our conclusion regarding US hegemony (or asymmetric dominance in the US-EA cross-border relations) are solidified with the alternative identification schemes.
Results
Layer 3 - Cross-border spillovers US-EA-US

Other regularities:

- Real shocks generate higher impulse responses, at least on impact.
- Financial shocks are transmitted (across borders) with a delay.
- The intensity in the transmission of shocks increases over time.
- Yet, since the Great Recession, the transmission of US shocks has weakened, meanwhile the negative transmission of EA shocks had also been reduced.
Subsection 2

Theoretical underpinnings
Theoretical underpinnings

Modelling approach

- Two sectors in a two-country version of the model in Iacoviello (2005).
- Infinite-horizon, two-country economy with a flexible exchange rate regime.
- The two countries represent the U.S. (big open economy) and the Euro Area (medium open economy).
- Prices are sticky in the intermediate goods sector.
- Central bank in each country sets the interest rate to respond to domestic inflation.
- 3 shocks: real (TFP, oil price), financial (LTV).
- Examine symmetric shock transmission, followed by sequential asymmetric dummy variable case.
Theoretical underpinnings

Symmetric shocks

- Symmetric TFP shock generates a higher impact on financial conditions (bonds/credit) in the US compared to the EA, and just marginally higher than in the real sector (consumption).

- A recessionary macroeconomic (oil price) shock leads to a stronger response in financial conditions (credit) in the US compared to the EA.

- Symmetric LTV shock generates a significantly higher response in the macroeconomic cycle (consumption, GDP, labour) in the US compared to EA.

- **US as a more leveraged economy, leading to stronger macro-financial transmission.**
Theoretical underpinnings

Asymmetric shocks

- Asymmetric productivity shock \((\text{originated in the US})\) renders similar responses in financial and real variables in the EA. Domestically (US), the response of financial conditions is persistent, as in the data.

- Asymmetric productivity shock \((\text{originated in the EA})\) renders weak response in the US, and much weaker than in the opposite case.

- Asymmetric financial shock \((\text{originated in the US})\) renders higher financial conditions responses in the EA than real activity. Moreover, they are more persistent.
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To end

Thank you

THANK YOU FOR YOUR ATTENTION!

Feel free to reach out or contact me via
Eddie.Gerba@bankofengland.co.uk
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Subsection 1

Data
## Annex

### US data

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<tr>
<th>ID</th>
<th>Trans. Description</th>
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<tr>
<td>F1</td>
<td>Nonfinancial Corporate Business; Net Worth, Billions of Dollars</td>
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<td>F2</td>
<td>Nonfinancial Corporate Business: Profits After Tax (without IVA and CCAdj), Billions of Dollars</td>
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<tr>
<td>F3</td>
<td>Private Residential Fixed Investment, Billions of Dollars</td>
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<td>F4</td>
<td>Households and Nonprofit Organizations; Net Worth, Billions of Dollars</td>
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<td>F5</td>
<td>Nonfinancial Corporate Business; Credit Market Instruments; Liability, Billions of Dollars</td>
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<td>F6</td>
<td>Households and Nonprofit Organizations; Credit Market Instruments; Liability, Billions of Dollars</td>
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<td>Households and Nonprofit Organizations; Home Mortgages; Liability, Billions of Dollars</td>
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<td>F8</td>
<td>All Sectors; Commercial Mortgages; Asset, Billions of Dollars</td>
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<td>F9</td>
<td>Households and Nonprofit Organizations; Total Time and Savings Deposits; Asset, Level, Billions of Dollars</td>
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<td>Households and nonprofit organizations; corporate equities; asset, Level, Billions of Dollars</td>
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<td>F11</td>
<td>Federal Government; Credit Market Instruments; Liability, Level, Billions of Dollars</td>
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<td>F13</td>
<td>M1 Money Stock, Billions of Dollars</td>
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<td>Velocity of M1 Money Stock, Ratio</td>
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<td>10-Year Treasury Constant Maturity Rate, Percent</td>
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<td>Total Consumer Credit Owned and Securitized, Outstanding, Billions of Dollars</td>
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<td>Households and Nonprofit Organizations; Consumer Credit; Liability, Billions of Dollars</td>
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<td>Real Gross Domestic Product, Billions of Chained 2009 Dollars</td>
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<td>Real Personal Consumption Expenditures, Billions of Chained 2009 Dollars</td>
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<td>R3</td>
<td>Nonfarm Business Sector: Real Compensation Per Hour, Index 2009=100</td>
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<td>R4</td>
<td>Real Gross Private Domestic Investment, Billions of Chained 2009 Dollars</td>
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<td>R5</td>
<td>Real Disposable Personal Income, Billions of Chained 2009 Dollars</td>
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<td>R6</td>
<td>Average Weekly Hours of Production and Nonsupervisory Employees: Manufacturing, Hours</td>
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<td>R7</td>
<td>All Employees: Manufacturing, Thousands of Persons</td>
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<td>R8</td>
<td>Nonfarm Business Sector: Real Output Per Hour of All Persons, Index 2009=100</td>
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<td>R9</td>
<td>Gross Fixed Capital Formation in United States, Billions of United States Dollars</td>
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*Note. The column “Trans.” of the table indicates the transformation made to the corresponding variable prior to include it in the model. “Trans.=1” indicates that the variable is expressed in levels. “Trans.=2” indicates that the variable is expressed in growth rates.*
# Annex

## Euro Area data

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Subsection 2

One country results - Cycles
Annex

United States cycles

(a) Financial Cycle

(b) Real Cycle
Annex

Euro Area cycles
United States

- Two larger financial contractions, while many macroeconomic downturns.
- Macroeconomic cycle is more erratic than financial.
- Average length of financial cycle: *pre-90*: 5-7 years; *post-90*: 7-10 years
- Average length of real cycle: 2-5 years throughout the sample.

Euro Area

- In pre-1996 period: Financial longer than real cycle
Annex

Output Gap Based on Real GDP

(a) US Cycle

(b) Euro Area Cycle
Annex

Financial Conditions in the US
Annex

Comparison

Compared to alternative financial indices:

- We find similarity to the non-financial leverage cycle.
- Long cycles and the long build-ups in particular since the 1990s are visible in both.
- The reversals are sharper in our financial cycle, and the flexibility in our framework allows for long-term movement in the trend.
- Compared to NFCI, our financial cycle is more informative on the particular phase of the cycle and the probability and severity of a subsequent reversal. The NFCI, on the other hand, is better suited for risk monitoring and analysis of risk build-up.

We believe our financial cycle is a good lead indicator; their swings anticipate those of credit-to-GDP and the business cycle.
Subsection 3

One country results - Macro-financial linkages
Annex

Contemporaneous dynamic correlation United States
Annex

Contemporaneous dynamic correlation Euro Area
Annex

Correlations

**United States**
- Between 1963 and 1992, correlation consistently declined to record low of 0.4.
- This lost ground was quickly regained in only 15 years, peaking at 0.67.
- However, it has declined since the start of the Great Recession, to 0.5 (end of 2017).
- Overall an oscillation around a mean of 0.5.

**Euro Area**
- Macro-financial interactions have steadily increased.
- Record high level of above 0.7 in 2011.
- Since adoption of the Euro, the rate of growth has been somewhat lower.
- **While the level of correlation higher in Euro Area, rate of growth larger in the US.**
Subsection 4

One country results - cross-sector transmissions
Annex

Impulse responses US - financial and real shocks

Response of the Real Activity to a shock in Financial Conditions

Response of the Financial Conditions to a shock in Real Activity
Annex

Impulse responses Euro Area - financial and real shocks
Annex

Impulse responses 3

United States

- Response of financial conditions to real shocks stable, but vice versa has increased since 2000.
- Effects of real shocks on financial conditions last longer and are cumulatively larger, but have varied less over time.
- **Pre-2000:** Real shocks have larger (peak) impact. **Post-2000:** Financial shocks have larger (peak) impact.

Euro Area

- Overall, real shocks have larger effect than financial shocks.
- Simultaneous increase in the responsiveness of real activity and financial conditions to shocks since early 1990’s.
- In absolute terms, shocks generate larger impact in the US (compared to Euro Area).
- On contrary transmission is more persistent in the Euro Area.
Subsection 5

One country results - factor loadings
Annex

Loadings: Financial US

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Figure: 1970 1990 2010

-0.5 0 0.5 1

F1 1970 1990 2010

-0.5 0 0.5 1

F2 1970 1990 2010

-0.5 0 0.5 1

F3 1970 1990 2010

-0.5 0 0.5 1

F4 1970 1990 2010

-0.5 0 0.5 1

F5 1970 1990 2010

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F18 1970 1990 2010

-0.5 0 0.5 1

F19 1970 1990 2010

-0.5 0 0.5 1

F20 1970 1990 2010

-0.5 0 0.5 1

F21 1970 1990 2010

-0.5 0 0.5 1

F22 1970 1990 2010

-0.5 0 0.5 1

F23
Annex

Loadings: Real US

[Graphs showing loadings for R1 to R9 from 1970 to 2010]
Annex

Loadings: Financial EA
Annex

Loadings: Real EA
Loadings

Standard macroeconomic indicators have slightly decreased in importance for the macroeconomic cycle. Yet, variables linked to the liability side of the non-financial sector have become increasingly determinant for characterizing the financial cycle.
Subsection 6

One country results - FEVD
Annex

Forecast error variance decomposition full model - US part 1
a) fin shock - fin cycle; b) fin shock - real cycle
Annex

Forecast error variance decomposition full model - US part 2

\(c\) real shock - fin cycle; \(d\) real shock - real cycle
Annex

Forecast error variance decomposition full model - EA part 1
a) fin shock - fin cycle; b) fin shock - real cycle
Annex

Forecast error variance decomposition full model - EA part 2

(c) real shock - fin cycle; (d) real shock - real cycle
Subsection 7

Alternative estimations - robustness checks
Annex

United States cycles - principal component

(a) Financial Cycle

(b) Real Cycle
Annex

Euro Area cycles - principal component

(a) Financial Cycle

(b) Real Cycle
Correlation between US macro-financial cycles - orthogonal innovations
Annex

Correlation between EA macro-financial cycles - orthogonal innovations
Annex

Correlation between US macro-financial cycles - break in volatility in 1985
## Annex

### Alternative identification scheme - global (joint) model

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*Note*: The symbol * indicates that no restriction is imposed in the corresponding relationship.
Annex

Cross-border impulse responses: US - to - EA - semirecursive scheme

Response of the E.A. Real Activity to a shock in U.S. Real Activity

Response of the E.A. Real Activity to a shock in U.S. Financial Conditions

Response of the E.A. Financial Conditions to a shock in U.S. Real Activity

Response of the E.A. Financial Conditions to a shock in U.S. Financial Conditions
Annex

Cross-border impulse responses: EA - to - US - semirecursive scheme

Response of the U.S. Real Activity to a shock in E.A. Real Activity

Response of the U.S. Real Activity to a shock in E.A. Financial Conditions

Response of the U.S. Financial Conditions to a shock in E.A. Real Activity

Response of the U.S. Financial Conditions to a shock in E.A. Financial Conditions
## Annex

### Alternative identification scheme - global (joint) model

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Cross-border impulse responses: **US - to - EA - Cholesky factorization**

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**Response of the E.A. Real Activity to a shock in U.S. Real Activity**

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**Response of the E.A. Financial Conditions to a shock in U.S. Real Activity**

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**Response of the E.A. Real Activity to a shock in U.S. Financial Conditions**

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**Response of the E.A. Financial Conditions to a shock in U.S. Financial Conditions**
Annex

Cross-border impulse responses: EA - to - US - Cholesky factorization
Subsection 8

Estimation algorithm
Annex

Steps

- **Step 1**: Sample $\tilde{f}_T$, and $\tilde{r}_T$ from $P(\tilde{f}_T, \tilde{r}_T|\tilde{\Lambda}_{x,T}, \tilde{\Phi}_T, \Sigma, \Omega, \Psi_\omega, \Psi_w, \tilde{Y}_T)$
- **Step 2**: Sample $\Psi_w$ from $P(\Psi_w|\tilde{\Phi}_T, \tilde{Y}_T)$
- **Step 3**: Sample $\tilde{\Phi}_T$ from $P(\tilde{\Phi}_T|\tilde{f}_T, \tilde{r}_T, \Psi_w, \Sigma, \tilde{Y}_T)$
- **Step 4**: Sample $\Sigma$ from $P(\Sigma|\tilde{f}_T, \tilde{r}_T, \tilde{\Phi}_T, \Psi_w, \tilde{Y}_T)$
- **Step 5**: Sample $\tilde{\Lambda}_{x,T}$ from $P(\tilde{\Lambda}_{x,T}|\tilde{f}_T, \tilde{r}_T, \Omega, \Psi_\omega, \tilde{Y}_T)$
- **Step 6**: Sample $\Psi_\omega$ from $P(\Psi_\omega|\tilde{\Lambda}_{x,T}, \tilde{Y}_T)$
- **Step 7**: Sample $\Omega$ from $P(\Omega|\tilde{f}_T, \tilde{r}_T, \tilde{\Lambda}_{x,T}, \tilde{Y}_T)$