Monetary Policy and Global Bank Lending: A Reversal Interest Rate Approach

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EEA Presentation
August 23, 2022
Credit channel of monetary policy in closed economy, lending *quantity*

Research Question:
Does monetary policy affect the allocation of bank lending across domestic and foreign countries?

Why do banks want to lend globally? Diversification

What prevents them from perfectly doing so? Friction

⇒ How does monetary policy contribute to these benefit and cost?
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In the context of open economy, domestic and cross-border lending *composition*

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Document novel facts on banks’ global lending allocation.
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⇒ Bias for home asset decreases until 2008 then increases to early 2000s level. (Coeurdacier and Rey, 2011)
⇒ The trend contrasts with continuously decreasing equity home bias.
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Evaluate the model implications in a dynamic general equilibrium setup.
Outline

Introduction

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Analytical Model

Dynamic Model

Conclusion

Appendix
Outline

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Appendix
Measuring Bank Lending Allocation

Index of Home Bias, reflecting under-investment in foreign assets comparing to average portfolio benchmark.

Illustrative example Home bias of country $i$'s banking sector:

$$ hb_i = 1 - \frac{\text{Foreign Share of } i's \text{ Portfolio}}{\text{Foreign Share of the World Portfolio}} $$

$\Rightarrow$ invest only in domestic assets.

$\Rightarrow$ invest proportionally to country $i$ vs. the rest of the world.

Bank Lending Data.

Quarterly frequency from 2001 with over thirty countries.

$\Rightarrow$ BIS Locational Banking Statistics

$\Rightarrow$ IMF International Financial Statistics

Data sources

Equity Home Bias
Measuring Bank Lending Allocation

Quantity of foreign lending?

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Illustrative example: Home bias of country $i$'s banking sector:

\[
\text{hb}_i \equiv 1 - \frac{\text{Foreign Share of } i\text{'s Portfolio}}{\text{Foreign (from } i\text{'s perspective) Share of the World Portfolio}}
\]

$\text{hb}_i = 1 \Rightarrow$ invest only in domestic assets.

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Ratio of foreign lending to total lending?
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Country-level Bank Home Bias

![Graph showing the trend of Country-level Bank Home Bias from 2002 to 2020. The graph indicates a decreasing trend over time, with a notable drop around 2008.](image-url)
Country-level Bank Home Bias

![Chart showing changes in bank home bias from 2002 to 2020.]
Structural Analysis of Lending Composition

Model

\[ y_t = A_0 + A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \quad t = 1, \cdots, T, \]

Specification

- four-variable: domestic and foreign uncertainty, bank asset, bank home bias
- five-variable: with asset decomposition
- six-variable: with macro indicators

Identification

- short-run identification
Figure 1: Impulse Response to foreign uncertainty shock.
Figure 2: FEVD to foreign uncertainty shock.
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Portfolio Model of Banking

Two countries \((i, j)\), each with a representative bank

- CARA utility, collect domestic deposit
- invest in domestic and cross-border asset
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Balance sheet decomposition of Country \(i\)’s bank

- asset: riskfree \(b_i\), risky domestic firm loan \(k_{ii}\), risky foreign firm loan \(k_{ij}\)
- liability: given equity \(e_i\), collect deposit \(d_i\), \(\delta = d_i / (d_i + e_i)\)
Portfolio Model of Banking

- **Asset**
  - Riskfree asset $b_i$
  - Domestic Loan $k_{ii}$
  - Foreign Loan $k_{ij}$
  - Total Asset $w_i$

- **Liability**
  - Equity $e_i$
  - Deposit $d_i$
  - Total Liability $w_i$
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Riskfree policy rate \(R^f\). Deposit rate \(R^d = (R^f)^\omega\) with pass-through elasticity \(\omega\).
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Riskfree policy rate \(R^f\). Deposit rate \(R^d = (R^f)^\omega\) with pass-through elasticity \(\omega\).

Risky returns are endogenous to banks through costly uncertainty management.
Endogenous Risky Returns

Risky loan returns consist of two shocks: TFP and uncertainty

\[ R_{li}^l = R_i + \epsilon_i, \quad R_{ij}^l = R_j + \epsilon_j. \]

\((R_i, R_j)\): jointly normal, mean \((\mu_i, \mu_j)\), variance \((\sigma_i^2, \sigma_j^2)\), correlation \(\rho\).

\((\epsilon_i, \epsilon_j)\): normal, zero mean, variance \(\sigma_{\epsilon}^2\), zero correlation.
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Management of uncertainty

- \( R_{ii}^l = R_i \) \( \epsilon_i \) eliminated with no cost
- \( R_{ij}^l = R_j + \epsilon_j \times P(m) \) \( \epsilon_j \) decreased by effort \( m \) with cost \( C(m, \Delta e_i') \)

\( \Delta e_i' = e_i' - e_i \) is profitability and is affected by policy rate \( R^f \).
Timing

0 Deposit Collection
households choose \( d_i \)

1 Portfolio Investment
bank chooses \( k_{ii}, k_{ij}, b_i \)

2 Interim Stage Management
bank chooses \( m \)

Loan Repayment
bank receives \( R_{ii}^l, R_{ij}^l \)

Project Realization
agents learn \( A_i, A_j, \epsilon_j \)

Managing Cost Realization
bank pays \( C \)
Interim Stage Management

Second stage pins down risky return variance:

- Domestic risky asset: \((\mu_i, \sigma^2_i)\)
- Foreign risky asset: \((\mu_j, \sigma^2_j)\), where \(\sigma^2_j\) is post management variance
Interim Stage Management
Second stage pins down risky return variance:

- Domestic risky asset: \((\mu_i, \sigma_i^2)\)
- Foreign risky asset: \((\mu_j, \sigma_j^2)\), where \(\sigma_j^2\) is post management variance

\[
\sigma_j^2 = \sigma_j^2 + \left\{ \begin{array}{c}
\text{TFP Shock Variance}
\end{array} \right.
\]

\[
\text{Reduction via Management} \times \sigma^2 \epsilon \left\{ \begin{array}{c}
\text{Uncertainty Shock Variance}
\end{array} \right.
\]

\[
\text{TFP Shock Variance} + \psi \text{E} \Delta e_i'
\]

\[
\text{Uncertainty Shock Variance} \times \sigma^2 \epsilon
\]

\[
\Delta e_i' = e_i' - e_i e_i' = (R_{li} - R_f) k_{ii} + (R_{lj} - R_f) k_{ij} + R_f w - R_d (R_f)
\]
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\[
\sigma_j^2 = \underbrace{\sigma_j^2}_{\text{① TFP Shock Variance}} + \underbrace{\sigma_\epsilon^2}_{\text{② Uncertainty Shock Variance}}
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Interim Stage Management

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- Domestic risky asset: \((\mu_i, \sigma_i^2)\)
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\[
\sigma_j^2 = \underbrace{\sigma_j^2}_{\text{1 TFP Shock Variance}} + \underbrace{\zeta \left( 1 - \psi \mathbb{E} [\Delta e_i'] \right)}_{\text{Reduction via Management}} \times \underbrace{\sigma_e^2}_{\text{2 Uncertainty Shock Variance}}
\]

- \(\zeta\) is overall management efficiency, \(\psi\) captures profitability effect
- \(\zeta\) and \(\psi\) come from parameterization of \(\mathcal{P}(m)\) and \(\mathcal{C}(m, \Delta e_i')\)

\[
\Delta e_i' = e_i' - e_i = (R_{ii}^l - R_f^c)k_{ii} + (R_{ij}^l - R_f^c)k_{ij} + R^f w - R^d (R^f) d_i
\]
Policy Rate and Bank Lending Allocation

Traditional risk premium channel:  $R^f \Rightarrow R_{ii}^l - R^f, \ R_{ij}^l - R^f \Rightarrow k_{ii}, k_{ij}$
Policy Rate and Bank Lending Allocation

Traditional risk premium channel: \( R^f \Rightarrow R^l_{ii} - R^f, R^l_{ij} - R^f \Rightarrow k_{ii}, k_{ij} \)

New channels due to uncertainty management: \( R^f \Rightarrow \Delta e_i' \Rightarrow \sigma^2_j \Rightarrow k_{ii}, k_{ij} \)

1. Monetary policy affects bank profitability via loan-deposit spread
2. Bank profitability alters uncertainty management decisions
3. Management changes optimal portfolio allocation
Policy Rate and Bank Lending Allocation

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New channels due to uncertainty management: \[ R^f \Rightarrow \Delta e_i' \Rightarrow \sigma_j^2 \Rightarrow k_{ii}, k_{ij} \]

1. Monetary policy affects bank profitability via loan-deposit spread
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\[ \Rightarrow \] Policy rate affects both the benefit and the cost of cross-border lending.
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1. Monetary policy affects bank profitability via loan-deposit spread
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\( \Rightarrow \) Policy rate affects both the benefit and the cost of cross-border lending.

Evaluate the overall effects? Two approaches:

1. Effect on relative preference: *home bias* of bank lending
2. Effect on absolute quantity: *reversal rates* for domestic and foreign lending
Optimal Portfolio Allocation

Portfolio solution is given by

\[
  k_{ii} \sim \left( \text{CARA-normal Portfolio} + \text{Uncertainty Friction Component} \right)
\]

\[
  k_{ij} \sim \left( \text{CARA-normal Portfolio} - \text{Uncertainty Friction Component} \right)
\]
Optimal Portfolio Allocation

Portfolio solution is given by

\[ k_{ii} \sim \left( \frac{(\mu_i - r_f)}{\alpha \sigma_i^2} - \frac{\tilde{\rho} \sigma_j}{\sigma_i} \frac{(\mu_j - r_f)}{\alpha \tilde{\sigma}_j^2} \right) + \frac{\tilde{\rho} \sigma_j}{\sigma_i} \frac{1}{2} \frac{\zeta \tilde{\sigma}_e^2}{\tilde{\sigma}_j^2}, \]

\[ k_{ij} \sim \left( \frac{(\mu_j - r_f)}{\alpha \tilde{\sigma}_j^2} - \frac{\tilde{\rho} \sigma_i}{\tilde{\sigma}_j} \frac{(\mu_i - r_f)}{\alpha \sigma_i^2} \right) - \frac{1}{2} \frac{\zeta \tilde{\sigma}_e^2}{\tilde{\sigma}_j^2}. \]
Optimal Portfolio Allocation

Portfolio solution is given by

\[
k_{ii} \sim \left( \text{CARA-normal Portfolio} + \frac{\tilde{\rho} \tilde{\sigma}_j \frac{1}{2} \zeta \tilde{\sigma}_e^2}{\sigma_i \tilde{\sigma}_j^2} \right)
\]

\[
k_{ij} \sim \left( \text{CARA-normal Portfolio} - \frac{\frac{1}{2} \zeta \tilde{\sigma}_e^2}{\tilde{\sigma}_j^2} \right)
\]
Optimal Portfolio Allocation

Portfolio solution is given by

\[ k_{ij} \sim \begin{cases} 
\text{CARA-normal Portfolio Solution} & + \frac{\tilde{\rho} \tilde{\sigma}_j}{\sigma_i} \frac{1}{2} \zeta \tilde{\sigma}_e^2 \frac{1}{\tilde{\sigma}_j^2} \\
\text{CARA-normal Portfolio Solution} & - \frac{1}{2} \zeta \tilde{\sigma}_e^2 \frac{1}{\tilde{\sigma}_j^2} 
\end{cases} \]

\[ \sigma_e^2 \neq 0: \text{additional terms due to uncertainty} \]
Optimal Portfolio Allocation

Portfolio solution is given by

\[
\begin{align*}
    k_{ii} & \sim \text{CARA-normal Portfolio Solution} + \frac{\tilde{\rho}\tilde{\sigma}_j 1/2 \tilde{\sigma}_\epsilon^2}{\sigma_i \tilde{\sigma}_j^2} \\
    k_{ij} & \sim \text{CARA-normal Portfolio Solution} - \frac{1/2 \tilde{\sigma}_\epsilon^2}{\tilde{\sigma}_j^2}
\end{align*}
\]

- \( \sigma^2_\epsilon \neq 0 \): additional terms due to uncertainty
- \( \psi \neq 0 \): augmented parameters \( \tilde{\sigma}_\epsilon(r^f), \tilde{\rho}(r^f), \tilde{\sigma}_j(r^f) \)
Optimal Portfolio Allocation

Portfolio solution is given by

\[
k_{ii} \sim \left( \text{CARA-normal Portfolio Solution} + \frac{\tilde{\rho}\tilde{\sigma}_j}{\sigma_i} \frac{1}{2} \zeta \tilde{\sigma}_e^2 \right) \]

\[
k_{ij} \sim \left( \text{CARA-normal Portfolio Solution} - \frac{1}{2} \zeta \tilde{\sigma}_e^2 \right) + \frac{\tilde{\rho}\tilde{\sigma}_j}{\tilde{\sigma}_j^2} \]

- $\sigma^2_\epsilon \neq 0$: additional terms due to uncertainty
- $\psi \neq 0$: augmented parameters $\tilde{\sigma}_\epsilon(r_f), \tilde{\rho}(r_f), \tilde{\sigma}_j(r_f)$
- As a result, wealth effect introduced: $w_i \Rightarrow \tilde{\sigma}_\epsilon(r_f) \Rightarrow (k_{ii}, k_{ij})$
Result 1: Policy Rates and Home Bias

\[ \mathcal{HB}_i = 1 - \frac{k_{ij}}{w_i} = 1 - \frac{1 + \frac{w_j}{w_i}}{1 + \frac{k_{jj}}{k_{ij}}} \]
Result 1: Policy Rates and Home Bias

\[ \mathcal{HB}_i = 1 - \frac{\frac{k_{ij}}{w_i}}{\frac{k_{ij} + k_{jj}}{w_i + w_j}} = 1 - \frac{1 + \frac{w_j}{w_i}}{1 + \frac{k_{jj}}{k_{ij}}} \]

\[ \delta = \frac{d}{w}: \text{deposit to asset ratio. } \omega: \text{pass-through elasticity from } R^f \text{ to deposit rate.} \]
Result 1: Policy Rates and Home Bias

\[ \mathcal{HB}_i = 1 - \frac{k_{ij}}{w_i} = 1 - \frac{1 + \frac{w_j}{w_i}}{1 + \frac{k_{jj}}{k_{ij}}} \]

\( \delta = \frac{d}{w} \): deposit to asset ratio. \( \omega \): pass-through elasticity from \( R^f \) to deposit rate.

\( \Rightarrow \omega = \delta^{-1} \), monetary policy tightening unambiguously increases home bias.
Result 1: Policy Rates and Home Bias

\[ HB_i = 1 - \frac{k_{ij}}{w_i + k_{ij}} = 1 - \frac{w_j}{1 + \frac{k_{jj}}{k_{ij}}} \]

\[ \delta = \frac{d}{w}: \text{deposit to asset ratio.} \quad \omega: \text{pass-through elasticity from } R^f \text{ to deposit rate.} \]

\[ \Rightarrow \omega = \delta^{-1}, \text{monetary policy tightening unambiguously increases home bias.} \]

\[ \Rightarrow \omega < \delta^{-1}, \text{there exists a unique separating line } \omega^N(w) \text{ on } (w, \omega) \text{ plane} \]

\[ \omega^N(w) = \frac{1}{\delta} \left( 1 - \frac{\tilde{w}^*}{w} \right). \]
Result 1: Policy Rates and Home Bias

\[ \mathcal{HB}_i = 1 - \frac{k_{ij}}{w_i k_{ij} + k_{jj}} = 1 - \frac{1 + \frac{w_i}{w_j}}{1 + \frac{k_{jj}}{k_{ij}}} \]

\[ \delta = \frac{d}{w} \]: deposit to asset ratio. \( \omega \): pass-through elasticity from \( R^f \) to deposit rate.

\( \Rightarrow \omega = \delta^{-1} \), monetary policy tightening unambiguously increases home bias.

\( \Rightarrow \omega < \delta^{-1} \), there exists a unique separating line \( \omega^N(w) \) on \((w, \omega)\) plane

\[ \omega^N(w) = \frac{1}{\delta} \left( 1 - \frac{\tilde{w}^*}{w} \right) \].

- If \( \omega > \omega^N(w) \), \( R^f \uparrow \) increases home bias.
- If \( \omega < \omega^N(w) \), \( R^f \uparrow \) reduces home bias.
- On this line, monetary policy does not affect bank home bias.
Result 1: Policy Rates and Home Bias

- **Normal Regime**
  - \( r^f \downarrow \), home bias \( \downarrow \)

- **Reverse Regime**
  - \( r^f \downarrow \), home bias \( \uparrow \)
Result 2: Reversal Rate Corridor of Lending

\[
\frac{d k_{ii}}{d r^f} > 0, \quad \frac{d k_{ij}}{d r^f} > 0 \quad \frac{d k_{ii}}{d r^f} < 0, \quad \frac{d k_{ij}}{d r^f} > 0 \quad \frac{d k_{ii}}{d r^f} < 0, \quad \frac{d k_{ij}}{d r^f} < 0
\]

\[ r_f^d \quad r_f^e \quad r_f^{hb} \]

- \( r_f^d \): reversal rate for domestic lending, -1\% by Brunnermeier and Koby (2019)
- \( r_f^f \): reversal rate for foreign lending \( \Rightarrow \) quantitative number?
- \( r_f^{hb} \): reversal rate for home bias \( \Rightarrow \) quantitative number?
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Dynamic Bank Problem

\[ V_t(e_{i,t}) \equiv \max \{\pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t}\} \]

\[ u(\pi_{i,t}) + \beta \mathbb{E}_t V_{t+1}(e_{i,t+1}) \]

s.t. \[ e_{i,t} = R_{ii,t} k_{ii,t} + R_{ij,t} k_{ij,t} + R_{t-1}^f b_{i,t-1} - R_t^d d_{i,t} \] (Evolution of equity)

\[ e_{i,t} + d_{i,t+1} = w_{i,t} \] (Total wealth)

\[ d_{i,t+1} = \delta w_{i,t} \] (Leverage constraint)

\[ w_{i,t} = \pi_{i,t} + (k_{ii,t+1} + k_{ij,t+1}) + b_{i,t} \] (Budget constraint)
Dynamic Bank Problem

\[ V_t(e_{i,t}) \equiv \max_{\{\pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t}\}} u(\pi_{i,t}) + \beta E_t V_{t+1}(e_{i,t+1}) \]

s.t. \[ e_{i,t} = R^l_{ii,t} k_{ii,t} + R^l_{ij,t} k_{ij,t} + R^f_{t-1} b_{i,t-1} - R^d_t d_{i,t} \] (Evolution of equity)

\[ e_{i,t} + d_{i,t+1} = w_{i,t} \] (Total wealth)

\[ d_{i,t+1} = \delta w_{i,t} \] (Leverage constraint)

\[ w_{i,t} = \pi_{i,t} + (k_{ii,t+1} + k_{ij,t+1}) + b_{i,t} \] (Budget constraint)

Ad hoc deposit supply schedule (Bianchi and Bigio, 2021)

\[ d_{t+1} = \Theta_t d \left( \frac{1}{1 + r_{t+1}^d} \right)^{-\zeta}, \quad \zeta > 0, \quad \Theta_t^d > 0 \]
Incomplete Market Equilibrium

An incomplete market equilibrium under this setup consists of a set of state contingent plans \( \{ \pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t} \}_{t=0}^{\infty} \), such that

1. \( \{ \pi_{i,t}, k_{ii,t+1}, k_{ij,t+1}, b_{i,t} \}_{t=0}^{\infty} \) maximizes the utility of bank \( i \) and \( j \).
2. Banks have perfect foresight on the sequence \( \{ r^f_t \}_{t=0}^{\infty} \).
3. Central bank allows to arbitrary hold or borrow reserves given \( r^f_t \).
4. Deposit market clears at deposit rate \( r^d_t = \omega r^f_t \).
Effective Risk Aversion

\[ k_{ii,t+1} \sim \left[ \frac{\mu_i - R^f_t}{\alpha \gamma_{t+1} \sigma_i^2} - \tilde{\rho} \frac{\mu_j - R^f_t}{\alpha \gamma_{t+1} \sigma_i \tilde{\sigma}_j} + \frac{1}{2} \tilde{\rho} \tilde{\zeta} i \tilde{\sigma}_e^2 \right] \]

\[ k_{ij,t+1} \sim \left[ \frac{\mu_j - R^f_t}{\alpha \gamma_{t+1} \tilde{\sigma}_j^2} - \tilde{\rho} \frac{\mu_i - R^f_t}{\alpha \gamma_{t+1} \sigma_i \tilde{\sigma}_j} - \frac{1}{2} \tilde{\zeta} i \tilde{\sigma}_e^2 \right] \]

\( \gamma_{t+1} \), effective risk aversion parameter à la Angeletos and Calvet (2006):

\[ \gamma_t = \gamma_{t+1} R^f_t \left[ 1 - A(R^f_t - 1) - \gamma_t \right] \]

With uncertainty management mechanism, \( A \neq 0 \), effects of future policy rate on risk aversion becomes ambiguous.
Conclusion

This paper: The role of monetary policy for banks’ global lending preference
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⇒ New evidence on banks’ cross-border lending allocation
  ▶ Panel data documentation of bank home bias patterns
  ▶ Identification of the causal effects

⇒ Closed-form analysis of the impact of policy rate on bank lending allocation

⇒ Combine profitability channel of monetary policy with uncertainty management

⇒ Pinpoint the effects of policy rate cut on bank lending composition changes

⇒ Quantitative assessment of lending reallocation consequences

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Data

**Bank Lending Data**
- BIS Locational Banking Statistics
- IMF International Financial Statistics

**Other Data**
- Equity Home Bias
- Uncertainty
- Banking sector characteristics
For foreign lending data, we use the Locational Banking Statistics (LBS) dataset from Bank for International Settlements. Our classification of bank is *location-oriented*, instead of nationality-oriented. We proceed to define our *foreign lending* as the *cross-border lending conducted by these banks resides in that country*.

For domestic lending, we use the variables from IMF International Financial Statistics (IFS) dataset. The entity that classify as bank in this data set is *Other Depository Corporations*. The domestic assets consists of three components: *Claims on Central Bank, Claims on Central Government*, and *Claim on Other Sector*. 
For foreign investment, we use data from Coordinated Portfolio Investment Survey (CPIS) dataset developed by IMF. The dataset gives detailed decomposition of each country’s foreign equity holding on a yearly basis, and one can specify both the origin and destination of the investment.

For domestic investment, take country $i$ for example.

- First, we collect data on the stock market capitalization of country $i$, which is the total size of its stock market.
- Second, we compute how much of country $i$’s equity is held by foreign investors. This is done by aggregating over all the other countries’ holding of country $i$’s equity.
- Lastly, we obtain domestic investor’s holding of domestic equity as the difference between the two.
Uncertainty

- **World uncertainty index** is a country-level index based on word-counting method. We take the Uncertainty Index measurement for country $i$ as the *domestic uncertainty* indicator. For *foreign uncertainty*, we construct it in two different methods.
  - The first method is to compute directly the weighted world average uncertainty without country $i$ as the foreign uncertainty for country $i$.
  - The second method is to regress the total weighted world average uncertainty on country $i$’s uncertainty and take the residual to be the foreign uncertainty to country $i$.

- **Economic policy uncertainty index** is an index based on newspaper coverage of economic policy. The data is available for less countries than World Uncertainty Index, so we keep it as our secondary measure for domestic and world uncertainty.
World and US Bank Home Bias

Notes: The dark line displays the average level of bank home bias of the countries in our sample at quarterly frequency. Weights are computed based on the size of their banking sectors’ total assets.
Bank Home Bias and Uncertainty

Note: Red dash line is lagged by 4 quarters.
Bank Home Bias and Profitability

Notes: The blue dash line shows the return on equity of banks, provided by Federal Reserve Bank of New York.
Foreign Uncertainty Shock

Specification

- four-variable: domestic and foreign uncertainty, bank asset, bank home bias
- five-variable: with asset decomposition
- six-variable: with macro indicators

Identification

- short-run identification

Improvement

- Uncertainty measurement
  - Uncertainty as TFP shock variances/risks or as noises
  - purged TFP from uncertainty measure?
Figure 3: Impulse Response to foreign uncertainty shock.
Figure 4: FEVD to foreign uncertainty shock.
Figure 5: Impulse Response to foreign uncertainty shock.
Figure 6: FEVD to foreign uncertainty shock.
Notes: Blue line is from short run identification. Red line is from max share identification.
Figure 7: FEVD to foreign uncertainty shock.
Domestic Uncertainty Shock

Specification

- six-variable: with macro indicators
Figure 8: Impulse Response to foreign uncertainty shock.
Figure 9: FEVD to foreign uncertainty shock.
Summary of Results

- foreign uncertainty shock is a strong driver of bank home bias, inducing significant increase in bank home bias. The forecast error variance decomposition (FEVD) shows that it explains up to half of the FEVD of bank home bias.
- The results are robust to adding macro variables and balance sheet variables.
- When applying the same identification method to domestic uncertainty shock, however, the response of bank home bias is not significant.
Second Stage Problem

Given investment portfolio, bank chooses managing effort $m^*$. 

$$m^* = \arg \max_m \mathbb{E} \left[ u\left( e_j(\mathcal{P}(m, k_{ij})) k_{ij} - C\left( m, k_{ij}, \Delta \tilde{e}_i' \right) \right) | \mathcal{I} \right].$$
Second Stage Problem

Given investment portfolio, bank chooses managing effort $m^*$.

$$m^* = \arg \max_m \mathbb{E} \left[ u \left( \epsilon_j(\mathcal{P}(m, k_{ij})) k_{ij} - C(m, k_{ij}, \Delta \tilde{e}_i') \right) |\mathcal{I} \right].$$

**Benefit** of managing: $m$ reduces the impact of uncertainty.
Second Stage Problem

Given investment portfolio, bank chooses managing effort $m^*$. 

$$m^* = \arg \max_m \mathbb{E} \left[ u \left( c_j(P(m, k_{ij})) k_{ij} - C(m, k_{ij}, \Delta \tilde{e}_i') \right) | \mathcal{I} \right].$$

**Benefit** of managing: $m$ reduces the impact of uncertainty

**Cost** of managing: $m$ induces an operational cost to be financed

(Brunnermeier and Koby (2019), Heider et al. (2017), Gropp et al. (2018))

⇒ Solve for $m^*$ under general elasticity parametrization of $P$ and $C$. 

Parameterization
Second Stage Problem

Given investment portfolio, bank chooses managing effort $m^*$. 

$$m^* = \arg \max_m \mathbb{E} \left[ u\left( e_j(\mathcal{P}(m, k_{ij})) k_{ij} - C(m, k_{ij}, \Delta \tilde{e}_i') \right) \mid \mathcal{I} \right].$$

**Benefit** of managing: $m$ reduces the impact of uncertainty

**Cost** of managing: $m$ induces an operational cost to be financed

- expected profit $\Delta \tilde{e}_i' = \tilde{e}_i' - e_i$ decreases cost
  (Brunnermeier and Koby (2019), Heider et al. (2017), Gropp et al. (2018))

- shadow price of a constraint at interim stage (Enders et al. (2011))
Second Stage Problem

Given investment portfolio, bank chooses managing effort $m^*$.

$$m^* = \arg \max_m \mathbb{E} \left[ u \left( c_j (P(m, k_{ij})) k_{ij} - C(m, k_{ij}, \Delta \tilde{e}_i') \right) |\mathcal{I} \right].$$

**Benefit** of managing: $m$ reduces the impact of uncertainty

**Cost** of managing: $m$ induces an operational cost to be financed

- expected profit $\Delta \tilde{e}_i' = \tilde{e}_i' - e_i$ decreases cost
  (Brunnermeier and Koby (2019), Heider et al. (2017), Gropp et al. (2018))

- shadow price of a constraint at interim stage (Enders et al. (2011))

$\Rightarrow$ Solve for $m^*$ under general elasticity parametrization of $P$ and $C$.  

Parameterization
Bank solves the maximization problem with CARA utility:

$$\max_{\{k_{ii}, k_{ij}, b_i\}} \mathbb{E} \left[ u(e'_i) \middle| \mathcal{I} \right]$$

subject to:

$$w_i = k_{ii} + k_{ij} + b_i \quad \text{(Budget constraint)}$$

$$e'_i = R_i^l k_{ii} + R_i^l k_{ij} + R^f b_i - R^d d_i \quad \text{(Next period equity)}$$
Portfolio Investment

Bank solves the maximization problem with CARA utility:

$$\max_{\{k_{ii}, k_{ij}, b_i\}} \mathbb{E} \left[ u(e_i') \right]$$

s.t. $w_i = k_{ii} + k_{ij} + b_i$ (Budget constraint)

$$e_i' = R^l_{ii}k_{ii} + R^l_{ij}k_{ij} + R^f b_i - R^d d_i$$ (Next period equity)
Profitability

$\Delta e'_i$ is profitability defined as

$$\Delta e'_i = e'_i - e_i = (1 - \omega \delta) w_i r^f + (R_i - R^f) k_{ij} + (R_j - R^f) k_{ij}$$

- $\omega \delta$: risk-free profit
- $w_i r^f$: risky domestic profit
- $R_i - R^f$: risky foreign profit
Portfolio Result

\[ k_{ii} = \left( 1 - \tilde{\rho}^2 \right)^{-1} \left( \frac{(\mu_i - r_f)}{\alpha \sigma_i^2} - \frac{\tilde{\rho} \tilde{\sigma}_j (\mu_j - r_f)}{\sigma_i \alpha \tilde{\sigma}_j^2} + \frac{\tilde{\rho} \tilde{\sigma}_j \frac{1}{2} \zeta \tilde{\sigma}_e^2}{\sigma_i^2 \tilde{\sigma}_j^2} \right), \]

\[ k_{ij} = \left( 1 - \tilde{\rho}^2 \right)^{-1} \left( \frac{(\mu_j - r_f)}{\alpha \tilde{\sigma}_j^2} - \frac{\tilde{\rho} \sigma_i (\mu_i - r_f)}{\tilde{\sigma}_j \alpha \sigma_i^2} - \frac{\frac{1}{2} \zeta \tilde{\sigma}_e^2}{\tilde{\sigma}_j^2} \right). \]
Recall the role of monetary policy rate in expected profitability.

\[
\mathbb{E} \left[ \Delta \tilde{e}_i' | I \right] = (1 - \omega \delta) w_i r^f + \theta (\mu_i - r^f) k_{ii} + \theta (\mu_j - r^f) k_{ij}
\]

- risk-free profit
- risky domestic profit
- risky foreign profit
Parameter Explained

Recall the role of monetary policy rate in expected profitability

\[
\mathbb{E} \left[ \Delta \tilde{e}_i | I \right] = (1 - \omega \delta) w_i r^f + \theta (\mu_i - r^f) k_{ii} + \theta (\mu_j - r^f) k_{ij}
\]

- risk-free profit
- risky domestic profit
- risky foreign profit

Attenuation of uncertainty friction: \( \tilde{\sigma}_e^2 = \sigma_e^2 \left[ 1 - \psi (1 - \omega \delta) w_i r^f \right] \)

- higher \( r^f \) implies higher risk-free earning, uncertainty management becoming less costly
Recall the role of monetary policy rate in expected profitability

\[ \mathbb{E} \left[ \Delta \tilde{e}_i | I \right] = (1 - \omega \delta) w_i r_f^f + \theta (\mu_i - r_f^f) k_{ii} + \theta (\mu_j - r_f^f) k_{ij} \]

- risk-free profit
- risky domestic profit
- risky foreign profit

Variance reduction for foreign investment:

\[ \bar{\sigma}_j^2 = \sigma_j^2 - \zeta_i \psi \theta (\mu_j - r_f^f) \sigma_e^2 \]

- uncertainty management has economy of scale for foreign investment
Parameter Explained

Recall the role of monetary policy rate in expected profitability

\[
E \left[ \Delta \tilde{e}_i | I \right] = (1 - \omega \delta) w_i r^f + \theta (\mu_i - r^f) k_{ii} + \theta (\mu_j - r^f) k_{ij}
\]

risk-free profit  risky domestic profit  risky foreign profit

Generalized correlation structure:

\[
\tilde{\rho} = \frac{(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta (\mu_i - r^f) \sigma^2_\epsilon)}{\sigma_i \tilde{\sigma}_j}.
\]

endogenous cost reduction mechanism changes the effective correlation of returns between domestic and foreign assets
Attenuation of uncertainty friction

\[
\tilde{\sigma}_\varepsilon^2 = \sigma_\varepsilon^2 (1 - \psi (1 - \omega \delta) w_i r_f)
\]

\[
\frac{d \tilde{\sigma}_\varepsilon^2}{dR_f} = -\sigma_\varepsilon^2 \psi (1 - \omega \delta) w_i < 0
\]

- The derivative of this channel of effect with respect to interest rate is always negative, meaning that the higher the interest rate, the lower the effective uncertainty variance.
- Higher interest rate implies higher interest rate margin as long as \( \omega < \delta^{-1} \), which implies higher profitability and thus lower cost of management.
Variance reduction for foreign investment

\[ \tilde{\sigma}_j^2 = \sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma^2_\epsilon \]

\[ \frac{d\tilde{\sigma}_j^2}{dr^f} = \zeta_i \psi \theta \sigma^2_\epsilon > 0 \]

- The derivative of this channel of effect with respect to interest rate is always positive, meaning that the higher the interest rate, the higher the effective fundamental variances.

- Higher interest rate implies lower risk premium for the foreign asset, which leads to less expected profits and less cost reduction.
Change in correlation structure

\[ \tilde{\rho} = \frac{(\rho \sigma_i \sigma_j - \frac{1}{2} \zeta_i \psi \theta (\mu_i - r^f) \sigma_e^2)}{\sigma_i (\sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2)^{\frac{1}{2}}} \]

\[ \frac{d\tilde{\rho}}{dr^f} = \frac{\left( \sigma_i (\sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2)^{\frac{1}{2}} \right)^{\frac{1}{2}} \zeta_i \psi \theta \sigma_e^2}{\left( \sigma_i (\sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2)^{\frac{1}{2}} \right)^2} \]

\[ = \frac{\left( \sigma_i^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2 \right)^{\frac{1}{2}}}{\left( \sigma_i (\sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2)^{\frac{1}{2}} \right)^2} \frac{1}{2} \zeta_i \psi \theta \sigma_e^2 \]

\[ = \frac{\left( \sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2 - \rho \sigma_i \sigma_j + \frac{1}{2} \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2 \right)}{\left( \sigma_i (\sigma_j^2 - \zeta_i \psi \theta (\mu_j - r^f) \sigma_e^2)^{\frac{1}{2}} \right)^2} \frac{1}{2} \zeta_i \psi \theta \sigma_e^2 \]
The effect of monetary policy rate on $\tilde{\rho}$ depends on the sign of

$$\left( \sigma_j^2 - \zeta \psi \theta (\mu_j - r^f) \sigma_\epsilon^2 - \rho \sigma_i \sigma_j + \frac{1}{2} \zeta \psi \theta (\mu_i - r^f) \sigma_\epsilon^2 \right).$$

With symmetric mean return assumption, it can be simplified to

$$\left( \sigma_j (\sigma_j - \rho \sigma_i) - \frac{1}{2} \zeta \psi \theta (\mu - r^f) \sigma_\epsilon^2 \right).$$

The effect is not constant and depends on the size of the monetary policy rate.
Complete Setup

Figure 10: Illustration of the Economy.