Reserve Assets and the Dollar

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This talk draws from joint work with Zhengyang Jiang and Hanno Lustig
U.S. Dollar Facts

1. There is a large quantity of dollar denominated bonds in the world; outsized relative to the
wealth share of the U.S. in the world
2. These bonds are issued by both U.S. and non-U.S. entities (banks, firms, governments)
3. U.S. external portfolio looks like a levered carry position, earning an “exorbitant privilege"
4. Safe dollar bonds have low returns, especially to foreign investors
5. The dollar currency appreciates, and the dollar bonds’ prices rise, during global downturns
6. The return on the dollar is a global risk factor
7. U.S. monetary policy has an outsized role in macro outcomes for countries around the world

Papers: Gourinchas and Rey [2007], Bruno and Shin [2014], Maggiori, Neiman, and Schreger
[2017], Jiang, Krishnamurthy, and Lustig [2018], Krishnamurthy and Lustig [2019] Rey [2013],
Miranda-Agrippino and Rey [2015], Lustig, Roussanov, and Verdelhan [2014]
Outline

• Some data on point (4), documenting low returns on dollar bonds.

• A model that ties the facts together by assuming that the world investor is willing to pay a convenience yield to own dollar safe assets.

• Why is it all about the dollar, and not another currency, or a basket of currencies? I will talk through some theory.
Dollar funding premium since crisis

Treasury Basis ≡ 1-year US Treasury − 1-year Foreign Govt swapped to dollars

- Demand for dollar assets drives negative basis
- Search for foreign yield: Basis is positive?
Dollar funding premium since crisis

Treasury Basis \equiv 1\text{-}year \text{US} \text{Treasury} - 1\text{-}year \text{Foreign} \text{Govt} \text{swapped to dollars}

Corp basis from Liao [2018], who shows corporate effect is particularly for short-maturity, high-grade bonds.
## Low returns to foreign holders of Treasury bonds

<table>
<thead>
<tr>
<th>Treasury Investor</th>
<th>Dollar-weighted</th>
<th>Time-weighted</th>
<th>Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official + Private</td>
<td>Nominal USD 5.46%</td>
<td>10.33</td>
<td>4.87</td>
</tr>
<tr>
<td></td>
<td>Local Currency 5.43</td>
<td>13.74</td>
<td>8.32</td>
</tr>
<tr>
<td>Private</td>
<td>Nominal USD 4.90</td>
<td>10.81</td>
<td>5.91</td>
</tr>
<tr>
<td></td>
<td>Local Currency 4.41</td>
<td>13.75</td>
<td>9.34</td>
</tr>
</tbody>
</table>

- TIC Data on net purchases of Treasurys by foreigners, 1980:Q1 to 2019:Q2
- Dollar-weighted is using actual purchases to compute an IRR; time-weighted is buy-and-hold
- We assume that purchases are of the entire Treasury market (Barclays U.S. Treasury Index)
U.S. Block: Households, Firms, and Central Bank

- \( t = 0, 1, 2 \ldots \)
- **Central Bank** sets \( i_t \)
- **Households**, OLG, consume home good [...for now; later add home and foreign goods]

\[
U_t = E_t[c_{t+1}]
\]

Supply labor \( l_t \leq \bar{l} \) when young (date \( t \)), consume when old (date \( t + 1 \)).

- **Firms** use \((l_t, k_t)\) produce output at \( t + 1 \):

\[
f(l_t, k_t) = A_{t+1}(l_t + k_t), \quad A_{t+1} > 1.
\]

- Capital can be costlessly converted into goods one-for-one, and vice-versa:

\[
\Rightarrow p_t = \text{[nominal] price of goods} = \text{price of labor} = \text{price of capital}
\]

- Firms run by owner-managers. Net worth of \( n_t \) at date \( t \) (\( = k_t \) in equilibrium).

\[
\sum_{t=1}^{\infty} (1 - \sigma)^{t-1} \sigma n_t.
\]

Gertler-Kiyotaki preferences. \( \sigma \) is death rate. Consume when die, otherwise accumulate.
Timeline

Households born, work \((l_t)\), save wage in bond \((d_t)\)

Bonds mature, household consumption

Manager net worth sink into production \(k_t\)

Borrow \((d_t)\) to pay workers

Output realized, debt repaid \(\Rightarrow k_{t+1}\)
**Borrowing, working capital, and production**

Firms face borrowing constraint, $\theta < 1$:

$$d_t \leq \theta \frac{p_{t+1}A_{t+1}(l_t + k_t)}{1 + i_t}.$$

Budget constraint for a firm at date $t$ is:

$$d_t - p_t l_t \geq 0,$$
Firms face borrowing constraint, $\theta < 1$:

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$$d_t = \frac{\theta p_{t+1}A_{t+1}(l_t + k_t)}{1 + i_t},$$

$$d_t \approx k_t \left( \frac{p_t \theta A_{t+1}}{(1 + i_t)} \right) - \theta A_{t+1}. $$

$\theta k_t \frac{p_t}{1 + i_t}$

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Monetary policy sets the real rate

- Firms set prices, wages \((p_t, p_{t+1})\) at start of date \(t\).
  - One period price-stickiness
- Then central bank sets rate,
  \[
  i_t = \bar{\pi} + \epsilon_t
  \]
  We study response to shock \(\epsilon_t\)
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We study response to shock \(\epsilon_t\)

- Optimal price setting for firms:
  - Households can also supply labor \(l'_t\) to an alternative I-sector.
  - Sector is CRS with productivity of one (so inferior to firms) but no financial constraints.
  - Set prices and wages at start of \(t\) as well,
    \[ \frac{p'_{t+1}}{p'_t} = 1 + \bar{\pi} \]

- Competitive labor/goods market means,
  \[ \pi_t = \frac{p_{t+1}}{p_t} - 1 = \bar{\pi} \]

\(\Rightarrow\) Equilibrium: Aggregate net worth \(N_t\) (=capital of \(K_t\)) is the only state-variable
**Monetary policy shock**

**Figure:** Impulse response to a U.S. monetary policy shock of 0.25%. Response variables are in %-deviation from SS values. Time in quarters.
**Safe asset investors**

- Risk neutral world investors who consume a world good (price one at all dates)
- World bonds pay $i_t^*$. 
- Demand for dollar safe assets (the dollar liquidity supplied by U.S. firms).
- Euler equation of safe asset investor:

$$i_t + E_t s_{t+1} - s_t = i_t^* - \lambda_t,$$

where $\lambda_t$ is convenience yield foreign investors assign to dollar liquidity.
  - Decreasing in quantity of dollar safe assets held:

$$\lambda_t = \lambda(Q_t) \text{ with } \lambda'(Q_t) < 0.$$

- Real exchange rate:

$$e_t = E_t \sum_{j=t}^{\infty} \lambda_j + E_t \sum_{j=t}^{\infty} (r_j - r_j^*) + \bar{e}$$

as in Jiang et al. [2018]
Quarterly Real Exchange Rate Change and News about Convenience Yields $N^\lambda_t$

News about current and future convenience yields $N^\lambda_t$ and real exchange rate changes $\Delta q_t$. From Jiang et al. [2018].
US investors’ carry trade

• US households will want to take the other side (“carry trade"):

\[ i^*_t + E_t s_{t+1} - s_t > i_t \]

• We assume short-sale constraint
  • US households cannot short-sell dollar bonds ... otherwise \( Q_t \uparrow \) and \( \lambda_t \to 0 \)
  • Only supply of dollar bonds are those issued by firms, and these are sold to foreign investors
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- Could follow Woodford [1990], Holmstrom and Tirole [1998] and have government tax \( t + 1 \) income to issue public debt, as dollar liquidity.
US investors’ carry trade via U.S. banks

- US households will want to take the other side (“carry trade”):
  \[ i_t^* + E_t s_{t+1} - s_t > i_t \]

- Assume U.S. banks (owned by both US households and foreign) intermediate a carry trade
  - Households don’t participate in foreign market; they sell dollar bonds to U.S. banks [Gabaix and Maggiori, 2015]
  - Banks sell the bonds to foreign safe asset investors
  - Invest proceeds in foreign bonds, earning carry trade return, returning profits to shareholders
  - Note: banks also face short-sale constraint and cannot sell more dollar bonds than they own.

- \( Q_t \) (produced by firms) is equilibrium quantity of dollar liquidity traded to world investors.
Trade balance

• We replace household preferences as:

\[ E_{t+1} \left[ \alpha_H \log c_{t+1,H} + \alpha_T \log c_{t+1,T} + \alpha_W \log w_{t+1} \right] \]

• The household maximizes utility subject to the budget constraint,

\[ \mathcal{E}_{t+1} c_{t+1,H} + c_{t+1,T} + w_{t+1} = w_{t+1}^- \equiv \mathcal{E}_{t+1} (1 + i_t - \pi_t) \bar{L} + w_t \left( \frac{V_{t+1} + \Pi_{t+1}^b}{V_t} \right). \]

• Log utility gives consumption proportional to wealth ⇒

\[ \frac{TB_{t+1}}{\mathcal{E}_{t+1}} = (1 + i_t - \pi_t) \bar{L} - (\alpha_T + \alpha_H) \frac{w_{t+1}^-}{\mathcal{E}_{t+1}} \]

• We assume rest-of-world accommodates trade flows at exchange rate (we have not closed in world GE).
Steady state

- Trade balance < 0:
  \[ TB^{SS} + w^{SS} \Pi^{SS} = 0 \]

- Exchange rate, interest rate:
  \[ e_t = E_t \sum_{j=t}^{\infty} \lambda_j + E_t \sum_{j=t}^{\infty} (r_j - r^*_j) + \bar{e} \]

  so that,
  \[ r^{SS} = r^{*,SS} - \lambda^{SS} \]
Monetary policy shock, again

**Figure:** Impulse response to a U.S. monetary policy shock of 0.25%
International Monetary Equilibrium

- U.S. balance sheet as per Gourinchas and Rey [2007]
- Shocks that reduce $Q_t$ (U.S. crisis ...) renders dollar liquidity scarce and appreciates the dollar as in Jiang et al. [2018]
- Bank carry profits/losses are exorbitant privilege and duty of Gourinchas, Rey, and Govillot [2010]
International Monetary Equilibrium

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- Maggiori puzzle: why does the dollar appreciate in a crisis if the US is short dollar bonds?
  - If US is short, then wealth is transferred to foreign in a crisis
  - Then to clear goods market, dollar has to depreciate.
Wealth gain of U.S. in a global flight-to-dollar

**Figure:** Impulse response to a safe asset demand shock of 10 basis points and a US nominal interest rate shock of −10 basis points

- US dollar borrowing costs fall in a crisis (conv. yield rises), which is a gain to equity holders.
- US has the gold mine...
Data: Is there a wealth gain?

- Gourinchas, Rey, and Truempler [2012] compute that the U.S. loses $2.2 trillion on its NFA from 2007Q4 to 2009Q1.
  - US carry trade flow losses
- Our computation:
  - Total financial assets of US (equities + bonds + deposits) falls by $9.0 trillion from 2007Q4 to 2009Q1
  - Canada+UK+Germany+France+Japan: Total financial assets fall by $13.7 trillion
- Relative asset gain for US that is shared $(13.7 - 9 = 4.7 \approx 2 \times 2.2)$ almost perfectly
  - Another reason why the US is the natural safe asset issuer.
Foreign country: Households and firms

Almost same as U.S. model but a real model with no price stickiness

- OLG households consume world good and supply labor
- Firms:
  \[ f(l_t^*, k_t^*) = A_{t+1}^*(l_t^* + k_t^*), \quad A_{t+1}^* > 1 + i_t^* \]
- Borrowing constraint, parameterized by \( \theta_t^* \).
**Borrowing choices**

Local (non-dollar) currency:
- Borrowing constraint:
  \[ d_t^* \leq \theta^* \frac{A_{t+1}(l_t^* + k_t^*)}{1 + i_t^*}. \]

Dollar borrowing:
- U.I.P. violation:
  \[ i_t < i_t^* + E_t s_{t+1} - s_t \quad (= i_t^* - \lambda_t) \]
- Borrowing constraint on \( Q_t^* \) of dollar bonds:
  \[ Q_t^* (1 + i_t) E_t S_{t+1} \leq \theta^* A_{t+1}^* (k_t^* + Q_t^* S_t) \]
  repayment in foreign currency foreign currency proceeds
Borrowing choices

Dollar borrowing:

- Borrowing constraint on $Q_t^*$ of dollar bonds:

$$Q_t^*(1 + i_t)E_{t+1}S_t \leq \theta^*A_{t+1}(k_t^* + Q_t^*S_t)$$

  - repayment in foreign currency
  - foreign currency proceeds

- Dollar borrowing as documented by Bruno and Shin [2014], Maggiori et al. [2017]

- *Most existing borrowing choice models rest on expensive local currency debt (i.e. high $i_t^*$). Ours is about cheap dollar borrowing cost (caused by high $\lambda_t$). The former models predict foreign borrowings; but are equally about $\$, Yen, SFR...*

- Invoicing in dollars [Gopinath, 2015] is one step away: firms invoice in dollars to match assets with liabilities
Equilibrium

- Dollar demand from world safe asset investors:
  \[ \lambda_t = \lambda(Q_t + Q_t^*) . \]

- Two state variables \((K_t, K_t^*)\)
- Equilibrium borrowing:
  - If \( \lambda_t < \lambda \), no reason to borrow in dollars and hedging benefit to borrowing local-currency
  - If \( \lambda_t > \bar{\lambda} \), only borrow in dollars
  - Otherwise indifferent and equilibrium pins down fraction of dollar borrowing

- For impulse responses, we assume parameterization such that firms go to the corner and borrow in dollars upto an exogenously specified max fraction of \( \gamma < 1 \).
U.S. monetary policy shock

Figure: Impulse response to a U.S. monetary policy shock of 0.25%. Blue is US, red is Foreign.
**US recession (no monetary policy response): Dollar appreciates; Foreign recession**

**Figure:** Impulse Responses to U.S Productivity Shock. $A_{t+1}$ falls $-1\%$. Blue is US, red is Foreign.
**Foreign shock to $\theta_t^*$:** Foreign recession; contagion; but no spillover to U.S.

**Figure:** Impulse Responses to Foreign Pledgability Shock: At time $t$ we reduce $\theta_t^*$ unexpectedly by 5%. The shock dissipates with autocorrelation of 0.7. Blue is US, red is Foreign 1, red-dash is Foreign 2.
Results

Spillover and Asymmetry

- U.S. shocks spill over to foreign
- Foreign shocks do not spill over to U.S.
- U.S. shocks do not spill back
- Foreign shock contagion
- Dollar is a global risk factor

See Rey [2013], Miranda-Agrippino and Rey [2015], Lustig et al. [2014]
We assume dollar safe asset demand as a primitive

And tie together key features of the world’s dollar equilibrium in a simple model:

- Dollar debt dominance
- US as world banker
- Safe dollar asset premium
- Flight to quality/dollar
- Asymmetric monetary policy spillovers
- Dollar as global risk factor
The $64 million dollar question: Why is it about the dollar?

- Any theory has to be about complementarities; otherwise, diversification motives push towards a multi-polar world
  - "I play dollar because you play dollar"
- Any theory has to deliver safe-asset demand: the ingredient that ties everything together
The $64 million dollar question: Why is it about the dollar?

- Any theory has to be about complementarities; otherwise, diversification motives push towards a multi-polar world
  - "I play dollar because you play dollar"
- Any theory has to deliver safe-asset demand: the ingredient that ties everything together
- But there are many sources of complementarity, which is the key one?
  1. Unit of account, input-output networks and externalities [Doepke and Schneider, 2017]
  2. Financial complementarities: liquidity and depth of dollar debt market [He et al., 2018]
  3. Denomination of trade invoicing and demand for dollars for settlement [Gopinath and Stein, 2019]
  4. ...others?


