Liquidity, Debt Denomination, and Currency Dominance

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Motivation

Currency dominance in global finance:

- **US dollar dominance**: large share of contracts denominated in $ by a broad cross-section of firms
- **Historical precedents**: Dutch florin (17\textsuperscript{th}–18\textsuperscript{th} c.), British pound sterling (19\textsuperscript{th}–20\textsuperscript{th} c.)

**Question**: what explains the emergence, persistence, and fall of these specific currencies?

**This paper**: liquidity-based theory for currency dominance in debt issuance

- Debt obligations are denominated in the unit required to be delivered at settlement
- Obtaining unit for settlement is less costly in more liquid money markets

US $ is attractive for issuance because large, liquid $ stock of instruments benefits settlement

**Key mechanism**: complementarity in liquidity supply (issuance) & demand (settlement)

⇒ Endogenous positive feedback: issuance begets more liquidity for settlement
Liquidity Force in the First Global Currency

International payments were made in **illiquid metallic coin** for much of history

- Hundreds of types; costly to verify, insure, and transport $\implies$ **uncertain supply** at settlement

**Bank of Amsterdam** (1609) overcame settlement frictions with **financial technology** *(bank florin)*

- Standardized **unit of account**: obtainable with coin deposits for payments via account transfers
- **Florin was liquid**: at any given time, no limit to florins available in Amsterdam

Florin-denominated “bill on Amsterdam” used internationally

- Yield advantage for florin-denominated assets

**Dutch florin** used as a financial unit of account rather than **(illiquid) Spanish “pieces of eight”**

- Despite Spain being bigger and wealthier economy with $6 \times$ trade volumes
Model of complementarity between liquidity supply and liquidity demand

1. Complementarity generates cross-section of debt issuance by different types of firms

Financial market liquidity generates dominance:

2. Unique dominant equilibrium arises from asymmetry in financial market liquidity
   - Historically seeded by large pool of safe government debt
     $\Rightarrow$ But government debt issuance can crowd out other safe debt issuers
   - Economic size and trade volumes not sufficient

Endogenous investment in liquidity generates additional complementarities:

3. Incentives & ability to invest are higher for dominant country

4. Dominant currency pricing (trade invoicing) complements dominant currency financing

5. Welfare: Liquidity provision is a natural monopoly $\rightarrow$ gains from international cooperation

6. Policy tools: Contingent liquidity provision
Related Literature

International monetary system:

Safe asset shortages:

US dollar dominance:

Search frictions in financial markets:
Model: Within-Country Setup
Debt Market: Firms and Investors

Preferences (risk neutral):
\[ u_{i}^{F,I} = c_0 + \beta c_1 + \beta^2 c_2, \quad c_t \geq 0 \]

Debt suppliers & demanders at \( t_0 \):
- Entrepreneur-owned Firms (mass \( F \)) and Government (mass \( G \)) issue bonds at \( t_0 \)
  - Entrepreneurs borrow to finance project which costs \( \beta^2 \), and generates profits \( \pi = 1 \)
- Investors (mass \( I \)) buy bonds, have endowments \( w \); each investor can invest in 1 bond

F and G Bonds:
- Face value 1, mature at \( t_2 \), indivisible
- **Zero default risk**, perfect substitutes \( \implies \) same endogenous price \( P_0 \)

Total bonds mass: \( m_I = F + G \leq I \)
Timing Mismatch Generates Liquidity Demand at $t_1$

Central element: potential for timing mismatch generates liquidity demand
- Firms receive profits $\pi = 1$ at either $t_1$ or $t_2$
- Probability of early profits $\phi \rightarrow$ mass $m_F = \phi F$ of mismatched firms

Gains from asset trade $(1 - \beta)$ possible in the market at $t_1$ if firm profits arrive early:

Consumption streams:

<table>
<thead>
<tr>
<th>Time</th>
<th>Firms</th>
<th>Investors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_0$</td>
<td>$P_0 - \beta^2$</td>
<td>$w - P_0$</td>
</tr>
<tr>
<td>$t_1$</td>
<td>$\eta(1 - \beta)$</td>
<td>$(1 - \eta)(1 - \beta) + \beta$</td>
</tr>
<tr>
<td>$t_2$</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
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Gains from asset trade \((1 - \beta)\) possible in the market at \( t_1 \) if firm profits arrive early:

\[
\begin{align*}
F + G \text{ issue bonds} & \quad \phi F \text{ (mass } m_F) \text{ with early profits} \\
I \text{ (mass } m_I) \text{ buys bonds} & \quad \text{can match with } m_I \text{ bond investors} \\
\end{align*}
\]

Firms demand liquidity \( m_F = \phi F \)
Investors supply liquidity \( m_I = F + G \)

Meeting probability \( \alpha_I \)
Meeting probability \( \alpha_F \)

Surplus \((1 - \eta)(1 - \beta)\)
Surplus \(\eta(1 - \beta)\)
Asset Market Equilibrium and Issuance Benefits

\[ t_0 \quad \text{Trading frictions} \quad t_1 \quad t_2 \]

\( F + G \) issue bonds at price \( P_0 \)

\( I \) (mass \( m_I \)) buys bonds

\( \phi F \) (mass \( m_F \)) with early profits can match with \( m_I \) bond investors

\( t_0 \): market at \( t_0 \) is Walrasian, so investor bids result in price

\[
P_0 = \frac{\alpha_I \beta (\beta + (1 - \eta)(1 - \beta))}{P(\text{Matched}) \times \text{PV of Sale Price}} + \frac{(1 - \alpha_I)\beta^2}{P(\text{Not Matched}) \times \text{PV of 1}}
\]

\( \alpha_I \): probability investor resells bond at \( t_1 \)

**Convenience yield** at \( t_0 \) captured by \( P_0 - \beta^2 = \beta(1 - \beta)(1 - \eta) \times \alpha_I \)

- A fully illiquid bond (\( \alpha_I = 0 \)) would be priced at \( \beta^2 \)

**Expected utility** from debt issuance for firm \( i \) is increasing \( \alpha_I \) and \( \alpha_F \):

\[
\mathbb{E}[u_i^F] = \beta(1 - \beta) \times \left[ (1 - \eta)\alpha_I + \eta\phi\alpha_F \right]
\]

Convenience yield at \( t_0 \)  
Benefit of settlement at \( t_1 \)
Matching function at $t_1$: number of meetings between firms (demanders) and investors (suppliers) is

$$n = \lambda m_F^\theta m_I^\theta, \quad \lambda > 0, \quad \theta > 1/2$$

Increasing returns


Meeting probabilities:

$$\alpha_F = \frac{n}{m_F} = \lambda m_I^\theta m_F^{\theta-1}, \quad P(\text{Firm finds a bond seller})$$

$$\alpha_I = \frac{n}{m_I} = \lambda m_F^\theta m_I^{\theta-1}, \quad P(\text{Bond seller finds a firm})$$

Expected firm utility given equilibrium prices and probabilities (taking $\theta = 1$ case):

$$E[u_i^F] = \lambda \beta (1 - \beta) \times \left[ (1 - \eta) m_F + \eta \phi m_I \right]$$

Convenience yield at $t_0$, increasing in liquidity demand $m_F$

Benefit of settlement at $t_1$, increasing in liquidity supply $m_I$
Investors \((m_I)\) hold liquidity at \(t_1\) that firms \((m_F)\) need. Who are these investors?

\(\text{\$ market today:}\)

- In the US: investors are retail or dealer banks
  - Dealer banks buy Treasuries & MBS \((G)\) at \(t_0\)
  - Access reserves via repo markets \(\rightarrow\) supply reserves (or deposits) at \(t_1\)

- Internationally: investors are central banks or global banks
  - Buy bonds \((G,F)\) at \(t_0\)
  - Provide liquidity to domestic firms at \(t_1\)

\(\implies\) Investors hold \$ assets in order to provide \$ liquidity
Result 1: Issuance Incentive Complementarity Matches Cross-section of Firms

Separate issuance motives into two types of issuers: liquidity suppliers (+) and liquidity demanders (−)

**Liquidity Suppliers** \((F^+):\) no settlement needs \((\phi_i^+ = 0)\) but bonds are liquid \((\lambda_i^+ > 0)\)

Benefit purely from convenience yield

\[
u_i^+ = \frac{\lambda_i^+ \beta(1-\beta)}{2} m_F \]

\(\implies\) Issuance contributes to \(m_f\) \(\implies\) raises utility for liquidity demanders \(m_F\)

- Example: safe government debt or firms like KFW

**Liquidity Demanders** \((F^-):\) need settlement \((\phi_i^- > 0)\) but bonds have no resale possibility \((\lambda_i^- = 0)\)

Benefit purely from settlement ease

\[
u_i^- = \frac{\lambda_i^- \beta(1-\beta)}{2} \phi m_I \]

\(\implies\) Issuance contributes to \(m_F\) \(\implies\) raises utility for liquidity suppliers \(m_I\)

- Example: lower-rated global corporates
Model: Two-Country Environment
Debt Denomination Choice

Two countries $j = A, B$ with fundamentals $\{G_j, F_j, \lambda_j\}$

Currency denomination choice for firms $i$ in each country

- Fixed cost $\propto K_i$ of foreign denomination
  - Add exchange rate volatility $\Rightarrow$ expected costs of balance sheet currency mismatch or hedging

Endogenous masses $\mathcal{M} = (m_{F,A}, m_{I,A}, m_{F,B}, m_{I,B})$

Four denomination possibilities with expected utility denoted:

$$U_{A\to A}(\mathcal{M}) \quad U_{A\to B}(\mathcal{M}, K_i)$$

$$U_{B\to B}(\mathcal{M}) \quad U_{B\to A}(\mathcal{M}, K_i)$$

Firm optimality requires threshold strategy: firms issue in foreign currency iff $K_i \leq \bar{K}$

- $H(K_i)$ is the (Pareto) CDF of $K_i \in [K, \infty) \rightarrow$ share $H(\bar{K})$ issues in foreign currency
Debt Denomination Choice

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Endogenous masses $M = (m_{F,A}, m_{I,A}, m_{F,B}, m_{I,B})$

Four denomination possibilities with expected utility denoted:

$$\bar{U}_{A\rightarrow A}(M(\bar{K})) \quad \bar{U}_{A\rightarrow B}(M(\bar{K}), \bar{K})$$

$$\bar{U}_{B\rightarrow B}(M(\bar{K})) \quad \bar{U}_{B\rightarrow A}(M(\bar{K}), \bar{K})$$

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- **Class BA** and class AB equilibria can arise
Define \( \hat{K} \) as the equilibrium value of \( \bar{K} \), equilibrium characterized by:

1. **Firm optimality:** the marginal firm \((K_i = \bar{K})\) has \( K_i = \hat{K} \) in equilibrium and satisfies

   \[
   \bar{U}_{j' \rightarrow j} (\hat{K}) = \bar{U}_{j' \rightarrow j'} (\hat{K})
   \]

2. **Market clearing:** given \( \hat{K} \), masses \( \mathcal{M} \) satisfy

   \[
   m_{l,j} = G_j + F_j + H(\hat{K})F_j, \quad m_{l,j'} = G_{j'} + \left[1 - H(\hat{K})\right] F_{j'}
   \]

   \[
   m_{F,j} = \phi \left[F_j + H(\hat{K})F_j\right], \quad m_{F,j'} = \phi \left[1 - H(\hat{K})\right] F_{j'}
   \]
Multiple Equilibria in Case with Symmetric Fundamentals

Class (BA) Equilibria: B firms switch to currency A

\[ \bar{U}_{B \rightarrow A} = \lambda_A [m_{F,A}(\bar{K}) + \phi m_{I,A}(\bar{K})] - \bar{K} \]

Expected utility of foreign denomination

\[ \bar{U}_{B \rightarrow B} = \lambda_B [m_{F,B}(\bar{K}) + \phi m_{I,B}(\bar{K})] \]

Expected utility of home denomination

Stable equilibrium points

Unstable equilibrium point

\( \hat{K}_0 \)  \( \hat{K}_1 \)  \( \hat{K}_2 \)  \( \bar{K} \)
Multiple Equilibria in Case with Symmetric Fundamentals

Class (BA) Equilibria: B firms switch to currency A

Class (AB) Equilibria: A firms switch to currency B
Contrast to Other Theories

1. **Costs** of asset & liability mismatch

   - Doepke Schneider (2017): credit chains for production + costly default
     \[ \rightarrow \] Socially optimal to coordinate on single denomination in all contracts
   - Gopinath Stein (2021) and Chahrour Valchev (2022): special case for trade transactions
     \[ \rightarrow \] Coordinate on denomination of assets (traded goods) and liabilities (debt)

\[ \rightarrow \] **Benefits** of liquid financial markets as source of dominance

   - Model also features costs of mismatch
   - Adding coordination on asset/liability denomination generates additional complementarity

2. **Investor demand** for safety

   - Maggiori (2017), Jiang Krishnamurthy Lustig (2021), Gourinchas Rey (2022): risk aversion in ROW or preference for $ drives demand
     \[ \rightarrow \] Incentive for safe issuance to capture convenience yield

\[ \rightarrow \] **Benefits** accrue to all issuers

   - Results do not depend on payoff heterogeneity or investor demand
Liquidity and Dominance
Throughout History
Result 2a: Historical Transitions - Fundamental Asymmetries Generate Dominance

- **Italian city-states** (15th – 16th c.) also prominent in trade and finance, but no dominant currency
- **Amsterdam** disrupted multipolarity; $G_A \uparrow$, $\lambda_A \uparrow$.

$$\begin{align*}
\bar{U}_{B\rightarrow A} &= \phi \lambda_A[G_A + 2F_A + 2H(\bar{K})F_B] - \bar{K} \\
\text{Increasing } G_A \text{ sufficiently leads to unique equilibrium selection}
\end{align*}$$
Amsterdam’s innovations to deepen florin market

- **Seed**: florin ($G$) were created because of settlement benefits for trade-intensive economy
  - Trade is settlement-intensive $\rightarrow \phi \approx \text{trade/GDP}$
  - Liquidity benefit for settlement ($\phi m_I$) increasing in $\phi$
  - $\phi_{Amsterdam} > \phi_{Spain}$

- **Confidence** in City of Amsterdam’s specie backing for florin was key for takeup

- **Innovations to invest in florin supply**: 1683 florin-for-specie repo facility created way to monetize gold/silver supplies [Figure]
  - Incentive use repo facility: convenience yield generated by liquidity demanders ($m_F$)
  - Issuance complementarity in cross-section of firms

$\implies$ **Increase in $G_A$**
Transition to British pound:

- Left panel: Bank of Amsterdam collapses in 1791 ($G_{Amsterdam} \downarrow$)
- Right panel: Britain wins Napoleonic Wars ($G_{Britain} \uparrow$) and ($G_{Amsterdam} \downarrow$)
Convenience Yield Dynamics and Crowding Out Safe Issuers

Convenience yield \( A \) = \( \lambda_A \frac{m_{F,A}^\theta}{m_{I,A}^{1-\theta}} \)

\( m_{F,A} = \phi(F_A + H(\hat{\mathcal{K}})F_B) \): liquidity demand \( \uparrow \) conv yield
\( m_{I,A} = G_A + F_A + H(\hat{\mathcal{K}})F_B \): liquidity supply \( \downarrow \) conv yield

Bounding \( \theta \): at \( \theta = 1 \), liquidity supply channel disappears

Convenience yield \( A \) = \( \lambda_A m_{F,A} \)

- \( \uparrow G_A \) has no direct effect (within BA equilibrium)
- \( \uparrow G_A \) has indirect effect through \( H(\hat{\mathcal{K}})F_B \Rightarrow \) raises \( m_{F,A} \) and convenience yield

For \( \theta < 1 \): increasing \( G_A \) can decrease convenience yield within an equilibrium:

- \( \rightarrow \) crowds out safe issuers \((F^+)\) who only benefit from conv yield
- \( \rightarrow \) crowds in liquidity-demanding firms \((F^-)\) that value settlement
Result 2c: Private Sector Size Has Ambiguous Impact on Dominance

- Left panel: A is dominant currency; $F_A \uparrow$ increases A dominance
- Right panel: B is dominant currency; $F_A \uparrow$ increases B dominance

Examples: Spain in 17th century, US in 19th century
Result 3a: Persistence - Sovereign Incentives to Supply Liquidity are Increasing in Dominance

Specify the government’s objective as

\[ W_j = G_j \left( P_{0,j} - \beta^2 \right) + F_j \int u_{i,j}^F(K_i) \, dH(K_i) \]

Seignorage conv. yield \hspace{1cm} Domestic firm utility

Consider: \( B \rightarrow A \) equilibrium with \( G_A > G_B, \lambda_A = \lambda_B, F_A = F_B \)

\[ W_A = \lambda_A \left[ G_A m_{F,A} + F_A (m_{F,A} + \phi m_{I,A}) \right] \]
\[ W_B = \lambda_B \left[ G_B m_{F,B} + F_B (1 - H(\hat{K}))(m_{F,B} + \phi m_{I,B}) \right] + U_{B \rightarrow A}. \]

1. Bigger incentive to create liquidity \((G)\) for the leader \((A)\): \( \frac{\partial W_A}{\partial G_A} > \frac{\partial W_B}{\partial G_B} \)

2. Complementarity: investment incentive reinforced by endogenous rise in entry \((\hat{K})\):

\[ \frac{\partial^2 W_A}{\partial G_A \partial \hat{K}} > 0, \quad \frac{\partial \hat{K}}{\partial G_A} > 0 \]
Result 3b: Sovereign Incentives to Supply Liquidity are Increasing in Dominance

Improving capacity of private sector to issue safe money-like assets also part of financial development

Extend model to include country-specific pledgeability parameter $\rho_j$

- After currency choice, firms find out if revenues are fully pledgeable (probability $\rho_j$) or not

Ex ante expectation of pledgeability is $\rho_j$, so equilibrium condition becomes:

$$\rho_A \left[ \lambda_A (m_{F,A} + \phi m_{I,A}) - \hat{K} \right] = \rho_B \left[ \lambda_B (m_{F,B} + \phi m_{I,B}) \right]$$

As in previous case, sovereign incentives to invest in firm pledgeability complementary to dominance:

$$\frac{\partial W_A}{\partial \rho_A} > \frac{\partial W_B}{\partial \rho_B}, \quad \frac{\partial^2 W_A}{\partial \rho_A \partial \hat{K}} > 0, \quad \frac{\partial \hat{K}}{\partial \rho_A} > 0$$
Bank of England’s changing role

- **Early history**: established in 1693 as private entity given special monopoly rights in return for lending to the crown
  - competed to maximize profits and often restricted market liquidity

- **19th century**:
  - Bank of England notes became legal tender in Bank Charter Act of 1825
  - Established role of Lender of Last Resort after Panic of 1847 (Alongside legal codification of private bill terms and default procedures)

⇒ **Commitment** to backstop private bills market: \( \uparrow G, \uparrow \rho \)

**International banks monetize trade flows** into money market instruments (Xu, 2022)

1. Lend abroad with “banker’s acceptances” (collateralized on goods)
2. Remit to London money market as high quality “bank bills”

As in Amsterdam, capturing **convenience yield** (+ **liquidity benefit** to firms) is incentive to create bills
International trade and finance are highly related

- Ex: bills of exchange in Amsterdam both *settlement instruments* for trade and source of *credit*

○ **So far:** Trade/GDP shapes demand for banking and commitment of the bank
  - If more revenues [exogenously] in dominant currency, lower FX mismatch reduces $K_i$ (as in Gopinath Stein 2021)
  - Shifting $H(K)$ to the left $\rightarrow$ **more entry** with $\hat{K}_1 > \hat{K}_0$:

\[
\lambda_A \phi \left[ 2F_A + G_A + 2F_B H(\hat{K}_0) \right] - \hat{K}_0 = \lambda_B \phi \left[ G_B + 2F_B (1 - H(\hat{K}_0)) \right]
\]

- If firms *choose* invoicing currency, generate trade dominance as by-product of financial dominance

$\Rightarrow$ Additional complementarity that reinforces dominant equilibrium

○ **Trade invoicing vs “liability” invoicing:** Liabilities 6X trade, with both working in same direction
Global planner has objective:

$$\mathcal{W} = W_A + W_B$$

**Socially optimal entry** > **competitive equilibrium** because entry carries positive liquidity externality

- First best ($K^*$) is a Pareto improvement over competitive equilibrium (with transfers)
- Optimal policy features subsidy to entry into currency $A$
Result 5: Welfare & Bretton Woods Arrangements

- Now examine shadow value of increasing liquidity $G_A$ from global and single-country perspective
  - If $\frac{\partial W}{\partial G_A} > \frac{\partial W_A}{\partial G_A}$, planner wants to increase $G_A$ beyond what privately optimal for A’s sovereign

- Direction hinges on relative importance of public ($G_B$) and private ($F_B$) borrowing of follower ($B$):
  \[
  H(\hat{K}) \frac{\lambda_A}{\lambda_B} > \frac{1}{2} \frac{G_B}{F_B} + [1 - H(\hat{K})] \iff \frac{\partial W}{\partial G_A} - \frac{\partial W_A}{\partial G_A} = \frac{\partial W_B}{\partial G_A} > 0
  \]

- If $F_B$ is sufficiently large, there are gains from international cooperation in liquidity supply
  - Historical analog: Bretton Woods → major economies coordinated on US-provided liquidity
  - Response to the classic Triffin dilemma: transfers of commitment (gold) to the US
Result 6: Aggregate Risk and State-Contingent Liquidity, Role of Swap Lines

Aggregate risk:

- State at $t_1$ is $\omega \in \Omega$ with probability $q_\omega \rightarrow$ aggregate liquidity demand shock: $\phi_\omega$
- State-contingent liquidity supply $G^A_\omega$ chosen in advance at $t_0$

Equilibrium indifference condition now features moments of the $(\phi_\omega, G^A_\omega)$ distribution:

$$\lambda_A \left( E[\phi_\omega] \left( 2(F_A + H(\hat{K})F_B) + E[G^A_\omega] \right) + \text{Cov}[\phi_\omega, G^A_\omega] \right) - \hat{K} = \lambda_B E[\phi_\omega] \left( 2(1 - H(\hat{K}))F_B + G_B \right)$$

- State-contingent liquidity provision (positive covariance) induces entry

Policy tool: Central bank swap lines that provide liquidity when it is most demanded

- Default makes currency less attractive, particularly if it negatively covaries with aggregate demand. Demise of Euro
Financial market liquidity is common thread for dominant currencies since 1609

- Seeded by largest pool of safe government-backed debt
- Entrenched by endogenous incentives and ability to invest in safe debt creation
- US dollar dominance today features all the sources of dominance highlighted:
  - Large, liquid, safe stock of T-Bills
  - Financial technologies to make private assets liquid (securitization, collateralization, repo)

20th century arrangements have coordinated on liquidity provision

- Explicit coordination during Bretton Woods
- Swap lines as policy tools today

Renminbi dominance question: current Chinese financial system lacks these elements
Thank you!

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