A Model of the International Monetary System

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The International Monetary System

- Defining features:
  - Exchange rate regime: fixed, floating, managed
  - Financial architecture: international institutions (WB, IMF), LoLR, risk-sharing agreements (reserve sharing agreements, swap lines)
  - Provision and use of international reserve assets

- Fundamental questions:
  - Hegemonic vs. multipolar system
  - Determinants of reserve status
  - System stability
  - Adequate supply of reserve assets
  - Gold-Exchange standard, floating exchange rates

- Little formal analysis
The International Monetary System: History and Thought

Genoa Conference

1870 WWI 1920

Gold Standard

Genoa Conference

1870 WWI 1920

Genoa Conference

1870 WWI 1920

Gold Exchange Standard £ & $

Nurkse Instability (1961)

Keynes Gold Scarcity (1923)

Triffin Dilemma (1961)

1971 Floating Exchange Rates $

Kindelberger World Banker (1961)


1920 Genoa Conference

1870 WWI 1920

Gold Exchange Standard £ & $

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Keynes Gold Scarcity (1923)

Triffin Dilemma (1961)

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Kindelberger World Banker (1961)


1920 Genoa Conference
Some reflections on the International Monetary System

- **Keynes (1923):** argued against the return to gold standard at pre-WWI parities because scarcity of gold would have caused recession

- **Nurkse (1944):** argued that multipolar systems are inherently unstable since investors attempt to coordinate on which country, the US or the UK, will be the ultimate safe asset provider

- **Triffin (1961):** the system is fundamentally unstable since the US cannot simultaneously accommodate the demand for reserve assets and maintain a credible conversion of dollar to gold

- **Kindelberg (1963):** the system is stable, the US acts as a banker to the world, liabilities are backed by assets

- **Eichengreen (2011):** argues that a multipolar world (US, China, Europe) is no less stable. It increases supply of reserve assets and reduces monopoly rents
Some History and Stylized Facts about the IMS

Fact 1: shortage of reserve assets in 1920-1935

- After WWI countries return to gold pegs (at pre-war parity)
- Gold supply too low to accommodate demand for reserves
- Most central banks change statute to include monetary assets as reserves: the Gold-Exchange standard
**Some History and Stylized Facts about the IMS**

**Fact 2:** Co-issuance of reserves in 1920-1931

- British pound dominant reserve currency, but US dollar is also used

Source: Eichengreen and Flandreau (2009)

- Reserves switch often between pounds and dollars: **Nurkse instability**
Some History and Stylized Facts about the IMS

Fact 3: The Gold-Exchange standard collapse

- In 1931 England depreciates the pound unexpectedly
- Major losses around the world...Banque de France goes “bankrupt”
- Global flight to gold, dollar reserves liquidated, US devalues in 1933

Source: Eichengreen and Flandreau (2009)
Fact 4: The Bretton Woods collapse in 1973

- Triffin (1961): predicted that the US would face a dilemma between supplying more dollar debt as a reserve asset and maintaining the credibility of the dollar convertibility to gold. Ultimately, the system would be brought down by a confidence crisis. This prediction is known as the Triffin Dilemma.


Source: Bordo (2017)
Some History and Stylized Facts about the IMS

Fact 5: Dollar reserves in a floating exchange rate system (1973-2016)

- USD remains the dominant reserve currency with a share of 60-80%

Source: Eichengreen, Chitu, Mehl (2014)

- Triffin logic remains: fiscal not just balance of payments problem
Previous Literature


The Hegemon Model

- Two periods: $t = 0, 1$. Two countries: Reserve country and RoW
- World risky asset with variance $\sigma^2$ in perfectly elastic supply:
  - $R_H^r > 1$ if no disaster, probability $(1 - \lambda)$
  - $R_L^r < 1$ if disaster, probability $\lambda$
- Reserve country:
  - Monopolistic supplier of a nominal bond that pays $R$ in Reserve currency
  - At $t = 1$, if disaster occurred, chooses whether to depreciate by $e_L < 1$
  - Risk neutral with time preference $\delta^{-1} = E[R^r]$
- RoW:
  - Risk averse: mean-variance preferences over $t = 1$ consumption
  - Receives endowment $w^*$ at $t = 0$ and invests in risky and safe assets
Limited Commitment Problem and Timing

- Limited exchange-rate commitment and Calvo (1988) timing:
  - $t = 0^-$: Reserve country decides how much debt $b$ to issue
  - $t = 0^+$: sunspot realized, RoW investors choose portfolio, $R$ determined
  - $t = 1$: shocks realized, Reserve country chooses whether to depreciate
Decision to Devalue at time $t=1$ in a Disaster

Depreciate iff:

$$bR(1 - e_L) > \tau(1 - e_L)$$

fiscal benefit of depreciation  \hspace{1cm} \text{cost of depreciation}

- Fiscal burden rule: devalue iff $bR > \tau$

- Direct cost

- Reduced form for (later) infinite-horizon commitment problem with probabilistic grim trigger strategies
Demand for Safe Assets

• Row agents maximize:

\[
\max_b \quad E[C_1^*] - \gamma \text{Var}[C_1^*]
\]

s.t. \( w^* = b + s^* \)

s.t. \( C_1^* = bR_e + s^*R_r \)

• If bond expected to be safe, finitely elastic demand:

\[
R - E[R_r] = -2\gamma \sigma^2 (w^* - b)
\]

• If bond expected to be risky, infinitely elastic demand:

\[
E'[R_e] - E[R_r] = 0 \quad \text{and} \quad 0 \leq b \leq w^*
\]

• In paper: liquidity benefits, network effects, private issuance

Assumptions: risky bond and risky asset are perfect substitutes \( e_L = \frac{R_l^r}{R_H^r} \), demand is downward sloping
The Three Regions of the International Monetary System

Unique Safe Equilibrium

Multiple Equilibria: Safe & Collapse
Select Collapse with prob. α

Unique Collapse Equilibrium

Safe Zone

Instability Zone

Collapse Zone

\[
\begin{align*}
b &\equiv \frac{\tau}{R_H^r}; \\
\bar{b} &\equiv -\bar{R}^r + 2w^*\gamma\sigma^2 + \sqrt{\left(\bar{R}^r - 2w^*\gamma\sigma^2\right)^2 + 8\gamma\sigma^2\tau} \\
&\quad \div 4\gamma\sigma^2
\end{align*}
\]
Endogenizing Issuance: Problem of Reserve Country

• **Monopolist** Reserve country maximizes:

\[
\max_{b,s} \ E^{-}[C_0 + \delta C_1 - \tau(1 - e)]
\]

\[
\text{s.t. } C_0 + s = w + b
\]

\[
\text{s.t. } C_1 = sR^r - bR(b)e
\]

• Since \( \delta^{-1} = E[R^r] \), problem reduces to maximizing expected rents:

\[
\max_b \ bE^{-}[R^r - R(b)e] - \lambda \alpha(b) \tau(1 - e_L) \over V(b)
\]
Equilibrium under Full Commitment

- Monopolist optimal supply: \( E[R^r] - R(b) - bR'(b) = 0 \)

- Monopoly rent (Exorbitant Privilege) by influencing price of risk:

\[
\frac{1}{2} w^* \left( E[R^r] - R^{FC} \right) = \frac{1}{2} \gamma \sigma^2 w^* \]
Equilibrium with Limited Commitment: Low Demand

- If $b^{FC}$ in Safe Zone, issue $b^{FC}$
  - RoW savings are sufficiently low: $\downarrow w^*$
  - Commitment technology is sufficiently good: $\uparrow \tau$
Equilibrium with Limited Commitment: High Demand

- If $b^{FC}$ in Instability zone, **Triffin dilemma**:
  - Issue $b$ $\Rightarrow$ safe
  - Issue $b^{FC}$ $\Rightarrow$ risk of collapse
- Bridge with **World Banker** view: banking is fragile
The Triffin Dilemma: Social vs. Private

- Within zones, too little issuance: monopolist does not internalize marginal increase in consumer surplus from marginal sale

- Across zones, countervailing force: monopolist does not internalize risk of destroying infra-marginal consumer surplus

- Depends on shape of demand curve $R(b)$:
  - Linear $\Rightarrow$ under-issuance
  - Sufficiently concave $\Rightarrow$ over-issuance

- Analogy with classic Spence (1975) analysis of monopolist quality/quantity choice
The Triffin Dilemma: Welfare Analysis

Generalized demand curve with liquidity preference (see paper)

- Generalized demand curve with liquidity preference (see paper)
The Triffin Dilemma: Welfare Analysis

- Varying level of commitment ($\tau$) and convexity of demand curve ($\eta$)
- Surfaces are the threshold crisis probabilities that make the Hegemon ($\alpha^*_m$) and the RoW ($\alpha^*_\text{row}$) indifferent between safe or risky issuance.
**Multipolar System**

- Multipolar world with $n$ identical countries-issuers of reserve currencies
- Issuers compete à la Cournot issuing $b_{i,n}$
- Problem of issuer $i$:
  \[
  \max_{b_{i,n}} E^{-}[b_{i,n}(R^f - R(b_{i,n}, b_{n-1}))]
  \]
- $b_{n-1}$ supply of safe assets from other issuers (random variable)
- If bond $i$ expected to be safe, finitely elastic demand:
  \[
  R(b_{i,n}, b_{n-1}) = E[R^f] - 2\gamma\sigma^2(w^* - b_{i,n} - b_{n-1})
  \]
- If bond expected to be risky, infinitely elastic demand:
  \[
  E'[R_e] - E[R^f] = 0
  \]
Benefits of Multipolar System: Competition

- Full commitment best response:
  \[ b_{i,n} = \frac{1}{2}(w^* - b_{n-1}) \]

- Equilibrium under full commitment:
  \[ b_{\text{FC}}^n = \frac{n}{n + 1} w^* \]
  \[ R_{\text{FC}}^n = E[R^r] - \frac{2}{n + 1} \gamma \sigma^2 w^* \]

- Same equilibrium under limited commitment for \( n \) sufficiently high

- First best obtains in perfect competition limit \( n \to \infty \)

- Benefits of multipolar systems (Eichengreen): low rents and stable

- Biggest benefits from first few entrants?
Costs of Multipolar System: Nurkse Instability

Nurkse (1944): multipolar systems are unstable because investor sentiment swings among candidates for reserve status

- **Equilibrium Selection 1**: if one country alone, then coordinate on safe. If two countries, one has most favorable expectations $\alpha_i = 0$ and the other the most unfavorable expectations $\alpha_{-i} = 1$
  - Asymmetric equilibrium (switches over time, in paper)

- **Equilibrium Selection 2**: if one country alone, then coordinate on safe. If two countries, one at random has most favorable expectations $\alpha_\tilde{i} = 0$ and the other the most unfavorable expectations $\alpha_{-\tilde{i}} = 1$
  - Instability from coordination problems among substitutable reserve assets
The Infinite Horizon Model

- Actions’ timing in all periods are identical to 1-period model
- Disaster risk i.i.d.
- RoW modeled as 1-period OLG
  - The Young invest endowment $w^*$
  - The Old consume proceeds of their earlier investment
- Reserve countries: 1-period nominal debt and devaluation $\{1, e_L\}$
- Strategies depend on devaluation (not issuance) history
- **Trigger Strategy Equilibrium:** with probability $\eta$, $R = R_H'$ for any $b$ in all future periods if in current period the Reserve country devalues if facing $R < R_H'$
The Hegemon Model: Infinite Horizon

- In each period, the Reserve country chooses not to devalue iff:

\[ \eta \geq bE[R^r] - R \geq bR(1 - e_L) \]

- Take \( \alpha = 0 \) for simplicity

- \( \approx \) endogenous \( \tau \)
The Hegemon Model: Infinite Horizon, Equilibrium Issuance

- **Full Commitment**: under full commitment optimal issuance is

  \[
  \max_b b \frac{E[R^r] - R(b)}{E[R^r] - 1}
  \]

  \(b^{FC}\) and \(R^{FC}\) are identical to the 1-period model

- **Limited Commitment**: equilibrium issuance is \(\min(b^{FC}, \bar{b})\)
Competition in the Infinite Horizon Model

- By analogy with 1-period model, best responses:
  
  \[ b_{i,n} = \min(b_{i,n}^{FC}(b_{n-1}), \bar{b}_n) \]

- Loss of commitment from competition through decreased rents

- So severe that total issuance independent of \( n \):
  
  \[ \bar{b}_n = \frac{\bar{b}_1}{n} \]

- Connected to, but different from Marimon, Nicolini, Teles (2012)
Nurkse Instability in the Infinite Horizon Model

- Assume IMS stable under Hegemon ($\alpha = 0$) with issuance $\bar{b}_{1,\alpha=0}$
- Consider IMS under duopoly
  
  **Equilibrium Selection:** one country safe, other not, random

- Individual issuance $\bar{b}_{1,\alpha=0.5} < \bar{b}_{1,\alpha=0}$

- IMS unstable and effective issuance of reserves falls

- Analogy with argument in banking literature of financial destabilization through competition via erosion of franchise value
Liquidity and Network Effects

- Capture liquidity/networks with “safe assets in utility function” (Stein 2012) with $B = (b, \tilde{b})^T$:

$$E[C_1^*] - \gamma \text{Var}(C_1^*) + (B^T \omega + B^T \Omega B) 1_{\{E[e]=1\}}$$

- Demand function isomorphic to basic model

$$R^s(b) = \bar{R}^r - 2\hat{\gamma}\sigma^2(\hat{w}^* - b)$$

where $\hat{\gamma} \equiv \gamma - \frac{2\Omega_{11} + \Omega_{12} + \Omega_{21}}{2\sigma^2}$ and $\hat{w}^* \equiv w^* \frac{\gamma}{\hat{\gamma}} + \frac{\omega_1}{2\hat{\gamma}\sigma^2}$. 
**Private Issuance**

- Mass $\mu$ of private issuers within the Hegemon country who can each issue one unit of debt denominated in reserve currency.

- Each issuer can issue at a cost $\eta$ distributed uniform over $[0, \xi]$.

- Total issuance

$$ b^T = b + \frac{\mu}{\xi} (\bar{R}_r - R^s(b^T)) $$

- Demand curve isomorphic to basic model

$$ \hat{R}^s(b) = \bar{R}_r - 2\hat{\gamma}\sigma^2(w^* - b) $$

where $\hat{\gamma} \equiv \frac{\gamma}{1 + \frac{\mu}{\xi} 2\gamma\sigma^2}$
More in Paper

- Endogenous emergence of a Hegemon
  - Characteristics of Hegemon: fiscal capacity, reputation, goods pricing
  - Amplification of differences: network effects and coordination problems
  - Natural monopoly from costly reputation building (large fixed costs, small variable costs)

- LoLR and risk-sharing arrangements

- Reserve currencies and funding currencies

- Sticky prices, Gold Exchange Standard, Floats, and ZLB
Gold-Exchange Standard

- Production, sticky wages: investable wealth $w^e + \bar{w}^\ell$

- Gold as a safe asset:
  - Pays “dividend” $D$ for sure tomorrow, infinitesimal supply
  - Price of gold $p_G = \frac{D}{R_s}$

- Gold Exchange Standard: $p_G$ constant $\iff R_s$ constant

- Equilibrium output determination:
  \[ R_s = E[R^r] - 2\gamma\sigma^2(w^e + \bar{w}\ell - b) \]

- Adjustment to expansion in world demand for gold/reserves ($\uparrow w^e$):
  - Expansion in monetary reserve assets ($\uparrow b$
  - Global recession ($\downarrow \ell^*$)
  - Abandonment of the gold standard ($\downarrow R_s, \uparrow p_G$)
Optimal Issuance Under the Gold-Exchange Standard

- Hegemon faces perfectly elastic demand curve
- May increase incentives to issue in the Instability region
- Issuance capped at $\bar{b}_G$: might not be able to achieve full employment
Expenditure Switching Effects

• With expenditure switching effects (e.g. non-tradable goods) ex-post benefit of Hegemon unilateral break of gold peg, further reduces ex-ante credibility

• Hegemon utility now $C_t + v_t(C_{NT},t)$

• $v'(C_{NT},t) = \frac{\bar{w}}{w^*} e_t$ or $C_{NT},t(e_t) = v_t^{-1}(\frac{\bar{w}}{w^*} e_t)$

• Further benefit from devaluation at $t = 1$ if output below potential:

  $v_1(C_{NT},t(e_L)) - v_1(C_{NT},t(1)) > 0$

• Isomorphic to reduction in $\tau$:

  $\bar{\tau} = \tau - \frac{v_1(C_{NT},t(e_L)) - v_1(C_{NT},t(1))}{1 - e_L} < \tau$
Modern Analog of Keynes Gold Recession: Floats at ZLB

• More flexible than gold-exchange standard at $R \geq 1$

• Similar economics at ZLB ($R = 1$)

• **Intuition:** common element across pegs to gold and ZLB is the “impossibility” to let the interest rate on reserve assets fall sufficiently
LoLR and Risk-Sharing Arrangements

- IMF facilities, reserve-sharing agreements, swap lines
- See paper
- Idiosyncratic shocks in each RoW country
- Precautionary savings increases demand for reserves assets
- Risk-sharing arrangements for idiosyncratic risk reduce demand for reserve assets
- Reduces probability of Collapse, stimulates economy if Gold Exchange Standard or ZLB
Emergence of a Hegemon: Fiscal Capacity and Networks

• Full commitment for simplicity
• Repaying $bR$ costs $bR\phi$ with $\phi > 1$ (marginal cost of public funds)
• Duopoly $i \in \{1, 2\}$ with $\phi_1 < \phi_2$
• Network/liquidity externality:
\[
R^s_i(b_i; b_{-i}) = \bar{R}r - 2\gamma\sigma^2(w^* - (b_i + b_{-i})) - \omega_1 - 2\Omega_{11}(b_i + b_{-i}) - (\Omega_{12} + \Omega_{21})b_i
\]
• Difference in equilibrium issuance:
\[
b_1 - b_2 = \frac{\bar{R}r\left(\frac{1}{\phi_1} - \frac{1}{\phi_2}\right)}{2(\gamma\sigma^2 - \Omega_{11} - \Omega_{12} - \Omega_{21})}
\]
• Endogenous amplification of small differences generates a Hegemon
Emergence of a Hegemon: IMS Meets IPS

• Complementarity between reserve and goods’ pricing currency
  • More prices rigid in given currency...
  • ...lower real impact of devaluation on repayment...
  • ...lower incentives to devalue...
  • ...competitive advantage for reserve currency ($\approx \tau \uparrow, e_L \downarrow$)

• Extreme example: all prices sticky in dollars $\rightarrow$ full commitment for US

• Prevalence of USD goods pricing in world trade (Gopinath (2015))
Emergence of a Hegemon: Natural Monopoly

- Ex-ante investment $K(\tau)$ at date $t = 0^-$
- Entry cost to benefit from share of oligopoly rents
- Large fixed cost, small variable cost
- Natural monopoly: only one or a few entrants
Emergence of a Hegemon: Fiscal Capacity and Coordination

- Fiscal capacity:
  - Repaying $bR$ costs $bR\phi$ with $\phi > 1$ to issuer conditional on $b > b$
  - Idea: convexity in distortionary effect of taxation and public debt

- Under limited commitment:
  - We set the probability of collapse such that each issuer is indifferent between issuing $b$ and issuing in the instability region, if the other issuer is issuing $b$
  - Assume two countries have small difference in their fiscal capacity:
    \[ \eta_H > \eta > \eta_L \quad \text{and} \quad \eta_H - \eta_L < \epsilon \]
  - Unique asymmetric equilibrium with $b_L >> b_H$
  - Endogenous amplification of small differences generates a Hegemon
Reserve and Funding Currencies: Third Party Issuance

- Consider small borrower in RoW

- Choice between funding in: home risky currency, foreign risky currency, or reserve currency

- Most models of original sin are about issuing in generic foreign currency

- Our model provides a trade-off from issuing in reserve currency
  - Low yields for dollar denominated debt: capture part of monopoly rents, Exorbitant Privilege
  - Unattractive state-contingent properties: real dollar debt value higher in disaster because of dollar appreciation

- Reserve currency is both saving and funding vehicle

- Third party issuance improves outcomes: doesn’t deteriorate Reserve country commitment
Reserve and Funding Currencies: Evidence

Third country issuance in USD and Pound in % of foreign currency debt

Source: Chitu, Eichengreen, Mehl (2014)
Conclusions

- A *Model* of the International Monetary System
- A basic model to organize thoughts on important topic
  - Triffin dilemma as a commitment problem
  - Social vs. private welfare: under or over issuance
  - IMS and world recessions under Gold-Exchange Standard and ZLB
  - Hegemon vs. Multipolar world: competition, rents, Nurkse’s instability, failure of Hayek’s competition in issuance