Limits of fiat money: Lessons from the Bank of Amsterdam

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1The usual ‘central bank’ disclaimer applies.
Road map

- Motivation: governance of money in a digital era
- Bank of Amsterdam: its heyday and downfall
- Key question: how does a bank that issues fiat money go bust?
- Global game: a model of fiat money and trade coins
- Conclusions: what can we learn?
Governance of money

- New (private) monies have appeared and shaken up the balance between public and private interests in money and payments

- ‘Cryptoisation’ reopened the debate on currency competition but economic arguments have not really changed (much) - “an old tale with a new chapter”..!

- But monetary sovereignty does require trust in fiat currency. This stresses the importance of central bank balance sheets and credible fiscal backing

- Central banks are recording massive losses nowadays. When does fiat money ‘break’..? The Bank of Amsterdam presents a vivid example
**Bank of Amsterdam (1609 - 1820)**

- Began as public deposit (payment) bank, effectively a stablecoin backed by metal coins; morphed into a proto-central bank issuing fiat money and adjusting money supply through asset sales/purchases to maintain stable value.

- In its heyday, Amsterdam Bank money was the first global currency for trade and finance.
An impeccable reputation

- Adam Smith on the Bank of Amsterdam:

  “At Amsterdam, however, no point of faith is better established than that for every guilder, circulated as Bank money, there is a correspondent guilder in gold or silver to be found in the treasure of the bank. The city is guarantee that it should be so.”

  (Adam Smith, Wealth of Nations, 1776)

- Reputation helped to maintain stable value of Bank money (relative to domestic coin - i.e. the ‘agio’)

Policy goal: Maintaining stable agio

Assets of the Bank of Amsterdam

Assets of the Bank of Amsterdam: close up

How does a bank that issues fiat money go bust?

- Fiat money is not debt that has to be repaid
- But this does not mean there are no limits
- Portfolio choice resulting from currency competition is a constraint
- Fiscal backstop imposes another constraint

- Key question: how negative must bank equity be before value of fiat money (relative to the alternative) collapses?
Model ingredients

- Merchants face portfolio choice between coins and Bank money
  - Gives rise to money demand function, which is subject to network effects
- Bank buys or sells coins to adjust the supply of Bank money to maintain a fixed agio, or premium
  - Akin to currency board maintaining target exchange rate
- Loans on the balance sheet place hard limit on how far money supply can be reduced by selling coins
  - Agio breaks below target when money demand falls below threshold; in limiting case, money value falls to zero
Model

- Three dates, indexed by \( \{0, 1, 2\} \)
- Economic fundamentals \( \Theta \), lognormally distributed
  - \( \theta \equiv \log \Theta \) has mean \( y \) and standard deviation \( 1/\sqrt{\alpha} \)
    - Snapshot of dynamic economy where fundamentals \( \{\theta_t\} \) follow a Gaussian random walk
- Two assets: coins and Bank money (accounts)
  - Coin is numeraire of value 1
Continuum of risk-neutral merchants, indexed by $i \in [0, 1]$

Merchant $i$’s valuation of Bank money is

$$v_i \cdot f(m)$$

where $f(m)$ is an increasing function of money holding $m$, reflecting network effects of Bank money and

$$v_i = \theta + \epsilon_i$$

where $\epsilon_i$ is i.i.d Gaussian with mean 0, std dev $1/\sqrt{\beta}$

Merchants know their own type, but must infer the distribution of other merchants’ types
Monetary operations of the Bank of Amsterdam

- Bank of Amsterdam balance sheet

\[ C + L = M + E \]

respectively coins, loans, money and equity

- Buys coins by crediting the seller’s account; sells coins debiting the buyers account (akin to QE/QT); purchases expand money stock, sales contract money stock

- Observes \( \theta \), and chooses money stock \( M(\theta) \) to maintain constant agio \( \bar{\gamma} \) on Bank money

\[ p = 1 + \bar{\gamma} \]
First, given risk neutrality, consider switching strategies for merchants around switching point $v^*$

Then show that the unique switching equilibrium is also the solution to iterated deletion of dominated strategies.
Money demand

- Money demand follows from the portfolio decision of merchants

\[ D(\theta) = \text{Prob} \left( v_i \geq v^* | \theta \right) = \Phi \left( \sqrt{\beta} (\theta - v^*) \right) \]

where \( \Phi(.) \) is standard normal c.d.f.

- Switching point \( v^* \) satisfies the indifference condition

\[ \frac{v^*}{1 + \bar{\gamma}} \cdot E \left( f | v^*, y \right) = 1 \]

Left-hand side is the expected payoff from holding bank money conditional on being the marginal type \( v^* \), while the right-hand side is the payoff to holding coins.
Switching point $v^*$ satisfies the indifference condition

$$\frac{v^*}{1 + \gamma} \cdot E(f|v^*, y) = 1$$

(1)

Conditional expectation follows from answer to the following question:

“My valuation is exactly $v^*$. What is the probability that proportion $z$ or less hold Bank money? Since everyone follows a switching strategy around $v^*$, money holding resulting from other merchants’ portfolio choice is the proportion of valuations that are above my own”
Money demand

- Answer to above question defines density over proportion of merchants that hold money
- Indifference condition is
  \[
  \frac{v^*}{1 + \bar{\gamma}} \int_0^1 f(z) dG(z|v^*, y) = 1
  \]
  where c.d.f. is
  \[
  G(z|v^*, y) = \Phi \left( \frac{\alpha}{\sqrt{\alpha + \beta}} (v^* - y) + \sqrt{\frac{\alpha + \beta}{\beta}} \Phi^{-1}(z) \right)
  \]
- Given \(\alpha\), note that \(\beta \to \infty\) implies \(G(z|v^*, y) \to z\), so that the density is uniform, and the prior mean \(y\) does not enter; but in general, the prior mean \(y\) shifts the whole distribution in a first-degree stochastic dominance sense
Money market equilibrium

To maintain the agio at $\bar{\gamma}$, money supply $M(\theta)$ has to satisfy

$$M(\theta) = D(\theta)$$

$$= \Phi \left( \sqrt{\beta} (\theta - \nu^*) \right)$$

$$= \Phi \left( \sqrt{\beta} (\theta - (1 + \bar{\gamma}) / E (f|\nu^*, y)) \right)$$

$$= \Phi \left( \sqrt{\beta} \left( \theta - (1 + \bar{\gamma}) / \int_{0}^{1} f(z) dG(z|\nu^*, y) \right) \right)$$

Trouble looms when money supply cannot contract sufficiently; the agio then breaks below target.
Break point

Balance sheet identity

\[ C + L = M + E \]

Since \( C \geq 0 \), agio breaks when \( M > L - E \)

▶ Break point \( \theta^* \) is the level of fundamentals below which the agio breaks; it is defined as solution to

\[ \Phi \left( \sqrt{\beta} (\theta^* - v^*) \right) = L - E \]

or

\[ \theta^* = v^* + \frac{\Phi^{-1}(L - E)}{\sqrt{\beta}} \] (2)

▶ Large loan portfolio and negative equity is a toxic mix that undermines fiat money
Results

- For any $\alpha$, there is a $\beta$ sufficiently large such that there is a unique, dominance solvable equilibrium. This equilibrium is in switching strategies around $v^*$.

- In the limit as $\alpha \to \infty$ and $\beta \to \infty$ but $\sqrt{\beta}/\alpha \to k$, money demand is

  \[
  D(\theta) = \begin{cases} 
  0 & \text{if } \theta < \theta^* \\
  1 & \text{if } \theta \geq \theta^*
  \end{cases}
  \]

  and price of bank money is

  \[
  p(\theta) = \begin{cases} 
  0 & \text{if } \theta < \theta^* \\
  1 + \bar{\gamma} & \text{if } \theta \geq \theta^*
  \end{cases}
  \]

  Break point $\theta^*(y)$ is a decreasing function of the ex ante mean of fundamentals $y$. 
Further research/policy questions

- Bank-sovereign nexus redux
  - Modern-day equivalent of merchants is the banking sector
  - What are the relevant portfolio decisions?
  - Where are the break points? Endogenous loan quality?

- Exchange rates as a barometer of fiat money value
  - Inflation is not always the result of excess demand
  - Spike in inflation and collapse of economic activity can go together, especially in emerging and developing economies undergoing financial crises

- Financial innovation on run dynamics
  - Cryptoisation: new privately issued monies
  - What is the outside option for relevant portfolio choice?