Limits of fiat money: Lessons from the Bank of Amsterdam[1]

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[1] The 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."

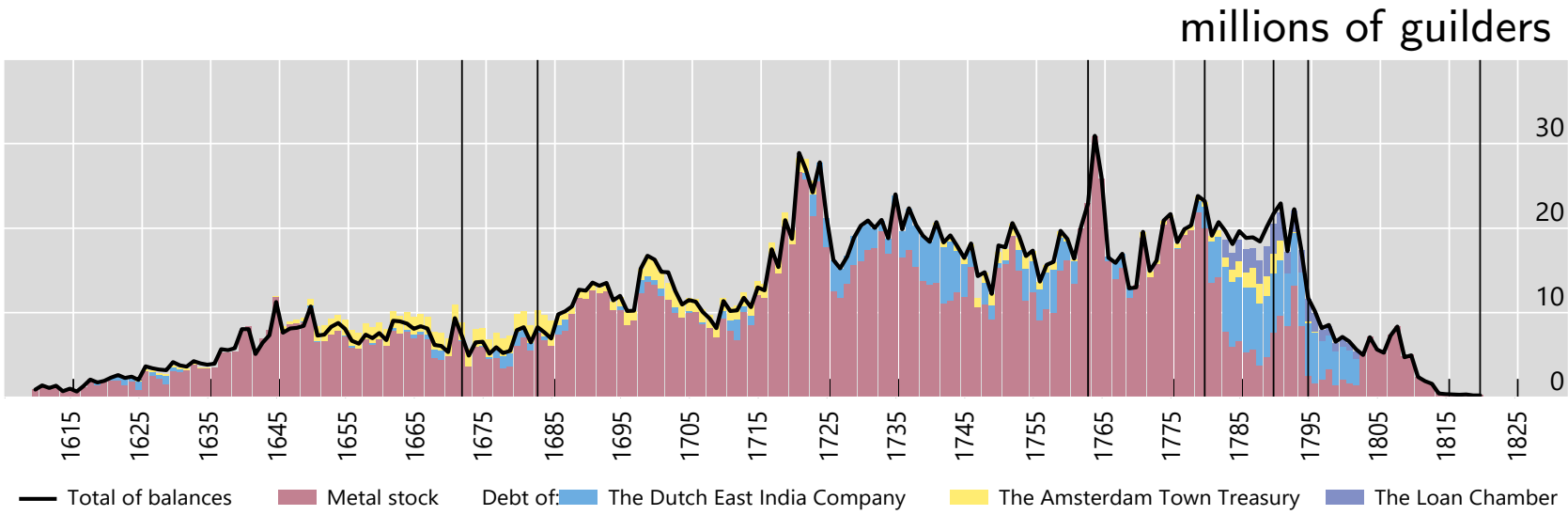
  (Adam Smith, Wealth of Nations, 1776)

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

Policy goal: Maintaining stable agio

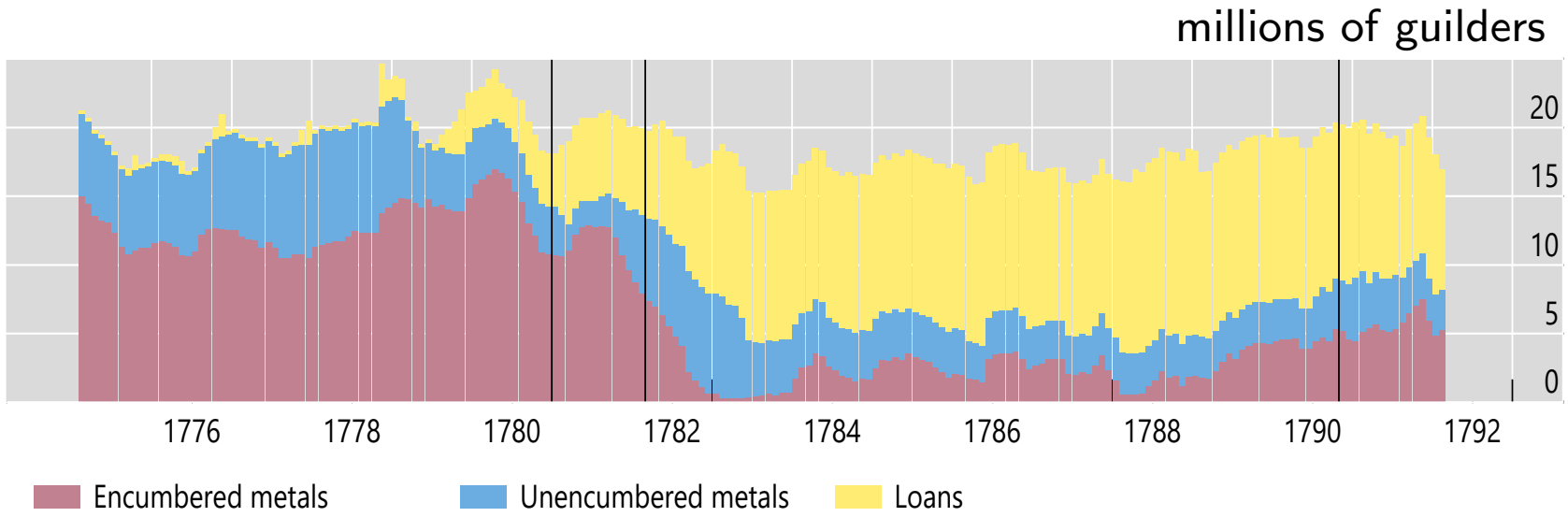
Source: Quinn and Roberds (2014, 2017)

Assets of the Bank of Amsterdam



Source: Quinn and Roberds (2014, 2017)

Assets of the Bank of Amsterdam: close up



Source: Quinn and Roberds (2014, 2017)

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 Θ, 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 increasing function of money holding m, reflecting network effects of Bank money and

$$v_i = \theta + \varepsilon_i$$

where ε_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 θ, and chooses money stock $M(\theta)$ to maintain constant agio $\bar{\gamma}$ on Bank money

$$p = 1 + \bar{\gamma}$$

Global game two-step solution procedure

- 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

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

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

Money demand

Switching point v^* satisfies the indifference condition

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

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

$$\frac{v^*}{1+\bar{\gamma}} \int_0^1 f(z)\, dG\left(z|v^*, y\right) = 1$$

where c.d.f. is

$$G\left(z|v^*, y\right) = \Phi\left(\frac{\alpha}{\sqrt{\alpha+\beta}}\left(v^* - y\right) + \sqrt{\frac{\alpha+\beta}{\beta}}\Phi^{-1}(z)\right)$$

- Given α, note that $\beta \to \infty$ implies $G\left(z|v^*, y\right) \to z$, 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

$$\begin{aligned} M(\theta) &= D(\theta) \\ &= \Phi\left(\sqrt{\beta}\left(\theta - v^*\right)\right) \\ &= \Phi\left(\sqrt{\beta}\left(\theta - \left(1+\bar{\gamma}\right)/E\left(f|v^*, y\right)\right)\right) \\ &= \Phi\left(\sqrt{\beta}\left(\theta - \left(1+\bar{\gamma}\right)/\int_0^1 f(z)\, dG\left(z|v^*, y\right)\right)\right) \end{aligned}$$

- 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 θ^* is the level of fundamentals below which the agio breaks; it is defined as solution to

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

or

$$\theta^* = v^* + \frac{\Phi^{-1}\left(L - E\right)}{\sqrt{\beta}} \tag{2}$$

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

Results

- For any α, there is a β 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?